THURSDAY, DECEMBER 25, 1884

THE "CHALLENGER" REPORTS

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 under the Command of Capt. George S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N. Zoology—Vol. X. (Published by Order of Her Majesty's Government, 1884.)

VOLUME X. of the "*Challenger* Reports" consists of over 630 pages of text, and is illustrated by 80 plates; it contains Parts xxvi. to xxx. of the Zoological Reports, all of which have been brought out under the able management of Mr. John Murray. It speaks a great deal for the energy and speed with which the publication of these Reports is conducted, when one notes that the whole of the manuscript of this large volume was only handed in between July 1883 and July 1884, and that a portion of Dr. R. Bergh's memoir had to be translated.

The Report on the Nudibranchs is by Dr. R. Bergh. Judging from the number and variety of species of this group already described from tropical seas, it is probable that it is to the tropics we should look for the headquarters of the group, and no doubt many and interesting species are yet to be discovered there. As few shallow-water dredgings were made during the cruise of the *Challenger*, it is not to be wondered at that the number of Nudibranchs collected was but twenty-five, including only one deep-sea form. The majority of the forms belonging to the Phylliroidæ and Æolidiadæ collected during the cruise are pelagic, and are represented by the genera Phylliroë, Glaucus, Fiona, &c.; some are littoral, such as *Janolus australis*, a single specimen of which was taken in the Arafura Sea, and one like the last referred to a new genus and species, *Cuthonella abyssicola*, was taken with the trawl in the Faroe Channel from a depth of 608 fathoms. Several new species belonging to the Tritoniadæ are described. Of the Dorididæ, two new genera and several new species are diagnosed. Of these the most interesting is *Bathydoris abyssorum*. This differs from all others of the family in the semi-globular form of the body, which is somewhat like that belonging to the genus Kalinga of Alder and Hancock, and which it also resembles in the characters of its branchia, these being composed of several separate branchial tufts, also in the development of soft conical papillæ upon the back. It has no frontal appendage, and the dorsal margin is very slightly pronounced. This new genus would appear to form a remarkable connecting link between the Tritoniadæ and the Dorididæ. The only specimen found was taken from a depth of 2425 fathoms, at Station 271, in the middle of the Pacific. Mr. Murray tells us that the body of the living animal was gelatinous and transparent, the foot was of a dark purple colour, the tentacles brown, and the gills and other external organs orange.

In an appendix, Dr. Bergh describes the only Onchidium in the *Challenger* collection as *O. melanopneumon*. Only one specimen was taken in shallow water, at Kandara, Fiji. Although some would regard the Onchidia as allied to the Nudibranchs, Dr. Bergh considers this view entirely erroneous. With regard to their phylogeny they have really nothing to do with Nudibranchs, and in a quite recent article in Gegenbaur's *Morphologisches Jahrbuch* (Band x. Heft 1, p. 172), he refutes the recent views of J. Brock. For comparison with the new species details of the anatomy of *O. tonganum* and *O. verruculatum* are given. This Report is illustrated by fourteen plates, for the most part devoted to anatomical details.

Dr. L. von Graff's Report on the Myzostomida collected during the voyage may be regarded as in some sense a continuation of his monograph on this interesting and little-known group. Of the 68 species enumerated in this Report, 52 appear as new. These Myzostomes are small disk-shaped animals, living attached to Crinoids, about whose affinities there has been up to the present a good deal of doubt, some placing them among the Worms near Tomopteris, others, as Dr. von Graff, among the Arachnids near the Tardigrades; and the discovery of a new form among the *Challenger* collection seems to confirm the correctness of this latter view. The author's class of Stelechopoda embraces the Tardigrades, Linguatulids, and Myzostomes, thus constituting a group of very lowly organised Arthropods. This Report shows that the Myzostomida do not form so uniform a group, either as to their habits or structure, as was formerly thought. It is prefaced by a very neat though brief account of the general structure of Myzostoma as far as it is known, with a graphic coloured diagrammatic representation and most minute details as to the general morphology, from which we condense the following important statements. While all the hitherto known forms were characterised by the peculiar radial arrangement of the organs of the body, several species are here described in which this arrangement is entirely lost; in some (*M. folium*) the body is greatly lengthened and the parapodia and suckers are found arranged in two parallel lines, while in a new genus (Stelechopus) not only has the external radial symmetry disappeared, but not even are the muscular septa and parapodial muscles convergent; hence, if, as the author believed long ago, the radial arrangement was an adaptation to the mechanism of fixation, or of the peculiar type of fixation, the want of it as in Stelechopus, which doubtless is a freely moving form, must be regarded as the primitive arrangement, and thus intensifies the affinity to the Tardigrades. It is interesting to find several forms entirely unprovided with suckers, though in some they may exist as mere rudimentary bodies; in one species (*M. calycotyle*) the suckers are stalked. The suggestion so aptly made by von Willemoës-Suhm that some of the Myzostomida were in all probability diœcious, has been amply verified by Dr. von Graff's researches. The two sexes when inhabiting the same cyst are at times unlike in appearance, the female being usually fifty to a hundred times as large as the male. The cyst-producing Myzostomes are of importance alike to the zoologist and the palæontologist, for these cysts have been found on the stalks of fossil Pentacrini, and as Dr. von Graff is continuing his investigations into the fossil form, he will be most grateful to any palæontologists who, having collections of fossil Crinoidea under their care, would examine the specimens and if they should notice the appearance of little pustules at the base of the pinnules, would communicate the facts to him. Of the sixty-seven species of Myzostomes

described, it must suffice to mention that elaborate illustrations are to be found of all the new ones, while Plate XVI. is altogether devoted to the illustrations of *Stelechopus hyocrini*. The body in this new type has a general similarity to a Tardigrade. Unfortunately the few specimens found being mounted in Canada balsam were somewhat altered in contour, but enough remained to surely indicate that the lateral margins of the body are nearly parallel in the middle, and become somewhat narrowed at either end. There is a conical caudal appendage. The largest specimen measured 3·5 mm. long, with a greatest diameter of ·9 mm.; the cuticle was chitinous; the parapodia, five on each side, were independent in action one of the other. The specimens were taken from species of Hyocrinus and Bathycrinus, off the Crozets, at depths of 1600 and 1375 fathoms. All the beautiful plates (sixteen in number) are from drawings by the author.

Dr. P. P. C. Hoek concludes his Report on the Cirripedia by the present series of chapters on the anatomy of the group. Unfortunately, the new forms of the deep-sea material being often represented by single specimens, it was impossible to work out their anatomy in any detail; but some excellent work has been done on forms formerly known. Thus the subject of the "complemental" males of Scalpellum is treated of, and every justice is done to the investigations of Darwin, who in 1851 first called attention to the strange phenomenon. "When we consider how much the methods of microscopical research have been improved in the thirty years which have elapsed, and that the male of *Scalpellum vulgare* which Darwin investigated is only 0·7 mm. in size, we can only wonder at the thoroughness of the information which he has given, and at the soundness of the conclusions at which he arrived." Dr. Hoek observed the complemental male in nineteen out of the forty-one new species described in the first part of the Report, but the unique specimens were not, and could not without spoiling them, be thoroughly examined. The structure of these males varies: some do not show a division of the body into a capitulum and a peduncle; a second group, while not showing either, are furnished with rudimentary valves; and a third not only have these latter but also show a distinct capitulum and peduncle. Another chapter treats of the anatomy of the complemental male in *Scalpellum ornatum*, one of the largest known. The subject of the Cypris-larvæ, of the segmental organs in the Cirripedia, of the cement apparatus, of Darwin's "true ovaria" (believed to be a pancreatic gland), the eye in Lepas, and the gynœcial organs, are also treated of and illustrated in six very beautifully executed plates from drawings by the author.

During the *Challenger* voyage human crania and skeletons were collected at several of the ports at which the ship called. These were intrusted to Prof. W. Turner for examination, and his first Report on the Human Crania forms part of the present volume. The crania were from the Admiralty Islands, the Sandwich Islands, the Chatham Islands, New Zealand, Australia, Terra del Fuego, Patagonia, and the Bush Race from South Africa. In another Report the other bones brought to England will be described. In the present Report, Prof. Turner has not restricted himself to the examination and mensuration of the skulls collected during the *Challenger's* voyage, but has, whenever possible, studied along with them skulls from the same localities, so that his Report may be looked on as an essay on the craniology of certain races of man. In all, there are described and tabulated one hundred and forty-three crania from aboriginal people who had lived in a state of uncivilisation. Not one of the skulls examined was metopic, though in a young male Australian, a Loyalty Islander, and in two New Guinea skulls traces of the frontal suture were seen in the glabella. In no skull was the malar bone either wholly or partially divided into two by a suture. In the skull of one Chatham Islander a wormian bone attained the magnitude of an intraparietal bone. In a good many of the crania epipteric bones were found in the pterion on one or both sides, but Prof. Turner points out that the squamoso-frontal articulation in the region of the pterion is to be regarded as an individual peculiarity, and is not a racial character. In each group of skulls, except the Fuegian, specimens with an infra-orbital suture were met with, a suture which, though of by no means rare occurrence in the human skull, has had very little attention paid to it by anatomists. A mesial third occipital condyle was present in an Admiralty, a Sandwich, a Chatham Islander, and in a New Zealander. As several of the peculiarities noted are normal conditions in other mammals, they must be regarded when occurring in man as reversions to a lower type. It becomes of interest, therefore, to inquire if such reversions occur more frequently in savage than in civilised races. To such an inquiry Prof. Turner answers, that, while the number of skulls he reports on is certainly too limited to base any broad generalisations on as to the relative frequency of occurrence of particular variations in the different races, yet there is obviously a larger proportion of important variations to be met with among them than would occur in a corresponding number of skulls of the white race. As results of the study of the races of men described in this Report, Prof. Turner points out that in South Africa, in the southern part of South America, and in Australia, races of men exist distinguished by the small capacity of their crania, by their low intellectual development, and in the case of the Bushmen and Fuegians, by their small stature and generally feeble physical configuration. The Australians and the now extinct Tasmanians were under the average size of Europeans. In the islands to the south and east of the great Asiatic continent, the Andamanese and other Negrito tribes are distinguished by their small stature, microcephalic crania, and low state of intelligence. "It is not unlikely that these people may in the early unwritten periods of human history have had in their respective continents a much wider range of distribution than at present, and have been gradually pushed southwards into their present restricted areas by the advance of the races, more powerful in both intellectual and physical development, which we see around them. If on their displacement they failed to mix with their invaders, their physical characters would remain pure. For isolation and interbreeding carried on through many centuries would necessarily preserve and even intensify the characteristic peculiarities of each race." This Report is accompanied by an atlas of seven plates.

The concluding Report in this volume is on the Cheilostomatous Polyzoa, by George Busk, F.R.S., with thirty-six plates, of which a detailed notice, by Dr. George J. Allman, appeared in our last week's number.

GEODESY AND MEASURES OF PRECISION

A Treatise on the Adjustment of Observations, with Applications to Geodetic Work and other Measures of Precision. By T. W. Wright, B.A., C.E., late Assistant Engineer United States Lake Survey. (New York: D. Van Nostrand, 1884.)

THIS treatise will be found a valuable addition to the literature of geodetic operations; the title is, however, misleading,—it implies a discussion of the various corrections required to allow for the effects of temperature, refraction, &c.; such corrections, however, are either omitted or only superficially dealt with, and the principal subject-matter is the adjustment of unavoidable errors by the method of least squares.

The work commences by a discussion of the various causes of error, and several practical hints are given as to how to diminish them. A remark in connection with personal error is worth quoting:—"A good observer, having taken all possible precautions with the adjustments of his instruments and knowing no reason for not doing good work, will feel a certain amount of indifference towards the results obtained. The man with a theory to substantiate is rarely a good observer, unless, indeed, he regards his theory as an enemy and not as a thing to be fondled and petted."

In the second chapter the usual law of error is stated, and the method of least squares is deduced therefrom, together with formulæ for calculating the mean square error, the probable error, and the average error. The author points out that the name "probable error" is unfortunate, and so we think; he is also of opinion that the average error might with advantage be more used than it is at present as a measure of the precision of a set of observations. This chapter is concluded by a most instructive discussion on the laws of error, based on various assumptions as regards the number of sources of unavoidable error. It is first supposed that there is only one source of error, and that all errors between certain limits are equally probable; the curve of error then becomes a finite straight line. The next case considers two independent sources of error, the curve then becomes two straight lines intersecting on the axis of y at an angle of 45°. In the third case three sources of error are assumed, and the curve of error is shown to consist of three parts, which together form a close approximation to the usual curve of error. The method of least squares is further developed in the succeeding three chapters, and applied to the adjustment of the direct observations of one unknown, to indirect and to condition observations. Various methods of solving the numerous resulting equations are given, both rigorous and approximate; amongst the latter the method of solution by successive approximations as used in reducing the primary triangulation of the Ordnance Survey of Great Britain is strongly recommended. The author also recommends the use of a calculating machine, or of Crelle's Tables, in order to diminish the arithmetical labour.

The remainder of the work is devoted to applying the foregoing to triangulation, to base-line measurements, to spirit levelling, to trigonometrical levelling, to the graduation of line measures, to the calibration of thermometers, and to the discovery of empirical formulæ. The application to triangulation is treated very fully, and several methods of solving the necessary equations are given and exemplified by means of examples. One of these examples is the adjustment of the angles of a quadrilateral taken from the Survey of the Great Lakes of North America, executed by the United States engineers; three methods of solution are given, one of them being that adopted by the United States engineers.

The author remarks very truly that it is a waste of time applying the rigid methods of adjustment to tertiary or even to secondary triangulation, and he proposes a method of successive approximations by first adjusting the angles at each station for the local conditions, and then using these adjusted values for the further adjustment in connection with the side and angle equations of the net. It may be mentioned that the reduction of the secondary triangulation of Great Britain, now being carried out, is effected by a graphic method applied after the angles have been locally adjusted: this method is found to give excellent results with far less labour than even an approximate method of calculation. The criticism on the title of the work is well exemplified in the chapters on base-line measurements and on the graduation of line measurements. For instance, there is no mention of the corrections required to be made to a base-line measurement to allow for errors in alignment or of level, for the effects of temperature and for reduction to sea-level. We think that at any rate a sketch of these and other sources of error and their methods of adjustment would not have been amiss.

The adjustment of the errors of trigonometrical levelling is very fully considered, and one of the examples proposed for solution is the adjustment of the levels taken trigonometrically during the triangulation executed to determine the axis of the St. Gothard tunnel.

The following remark is, we think, worth quoting:—"Closely allied to the preceding (elimination of accidental errors) is the common idea that if we have a poor set of observations good results can be derived from them according to the method of least squares, or that if work has been coarsely done such an adjustment will bring out results of a higher grade. A seeming accuracy is obtained in this way, but it is a very misleading one. The method of least squares is no philosopher's stone; it has no power to evolve reliable results from inferior work."

An excellent feature in the work is the illustration of the text by means of examples, embracing almost every possible case that occurs in practice. Some of these examples are fully worked out, others are proposed as exercises. Most of them are derived from geodetic work carried out in the United States. In conclusion we can strongly recommend this book.

OUR BOOK SHELF

On the Higher Teaching of Agriculture. By the Rev. J. B. McClellan, M.A. (Edinburgh: T. and A. Constable, 1884.)

NOT the least among the benefits of the International Health Exhibition was the series of Conferences held in connection therewith; and of these, one of the most valuable was the Conference on Education held in August last. Dr. Armstrong's paper on science-teaching in

schools has been already noticed in NATURE (vol. xxxi. p. 19), and the paper before us, by the Principal of the Royal Agricultural College, Cirencester, is another product of the Conferences. The author looks on agriculture broadly, as extending, like the theme of the poet of the "Georgics,"—

> " . . . super arvorum cultu per corumque
> Et super arboribus,"

and in a well-reasoned and well-written paper pleads for the teaching of the natural sciences, their facts, laws, methods, and applications to agriculture, to those who have the direction of agriculture in this country, or who seek fortunes in the soils of new countries. Cowley, two centuries ago, asked, "Who is there among our gentry that does not entertain a dancing-master for his children as soon as they can walk? But did ever any father provide a tutor for his son to instruct him betimes in the nature and improvements of that land which he intended to leave him?" Though this reproach is not deserved so much now as when it was written, it is still not wholly unmerited, and will so remain until those who have the possession and management of landed property shall receive some special training such as that sketched out by Mr. McClellan. This training, if fairly common, would do far more to mitigate agricultural depression than any amount of piecemeal legislation. The paper is a useful addendum to Mr. Jenkins's recent report on agricultural education, and it may be commended to the attention of landowners and others connected with agriculture.

The Text of Euclid's Geometry. Book I., uniformly and systematically arranged. With a discussion of Euclid's application of logical principles, copious notes, exercises, and a figure-book. By J. Dallin Paul, R.N. (Cambridge: Deighton, Bell, and Co., 1884.)

THIS is a "prodigious" work of 182 pages demy 8vo, printed on excellent paper, with clearly-drawn figures, devoted to the "painful" elucidation of all the difficulties to be found in the first book of Euclid's Geometry, with such other matter as hath been adumbrated in the above-cited title-page. The road may be an easy one to walk in, all stones of offence being carefully put on one side or so rearranged that the wayfarer may not stumble as he saunters along it, but it certainly is a long road. The tendency of modern agitation a few years ago was to condense our text-books with a view to get up geometry in the minimum of time, but experience has taught us that in the majority of cases junior boys are very tender-footed, and cannot be driven along the geometrical path, and so there has been a reversion to the "grand old" book with many an aid to lure the young into paths not naturally attractive to them. We do not find fault with these attempts—we have recently noticed in these columns two admirable editions of the "Elements,"—but Mr. Paul has taken, we think, an extreme course: at some perhaps not distant date, if this sort of editing is catching, we shall have a similarly got-up work devoted to Euclid's treatment of isosceles triangles with a preliminary chapter on an axiom.

Our author has had so much to do with Euclid that his views of life have possibly got to be Euclid-tinted, and he sees nothing but Euclid! It would be no wonder, for his own words are, in deprecation of the presumption of adding another edition to the many that have gone before, "having been teaching Euclid almost daily for the last twenty years to pupils who, before coming under his tuition, had learnt something of geometry from the different text-books in use during that time, he ventures to think that this experience has made manifest to him the principal advantages and disadvantages of these numerous works, and thereby enabled him to present the propositions in the form most likely to be of educational value to those who are beginning either to learn or to teach the subject." We have allowed the author to put so much in evidence that the majority of our readers may gather that this is not "just the book they wanted" for themselves, and yet may see the scope of Mr. Paul's labours.

We cannot commend the author's action in placing the notes on the propositions in the early part of the book; experience has shown him that when placed in their usual position at the end they are passed by, but their actual position here offends *our* eye, and will not, we fancy, secure the writer's object. We regret that the writer has spent so much time and thought to so little purpose, as we believe, for we cannot imagine who will be the public that will purchase his book, its size and price are a bar to its introduction into school use. We close with remarking that there is a good deal that may be of use to (say) a pupil-teacher, or to one who is not strong in geometry and yet has to teach young pupils; but much, if not all, of this, can be got in handier text-books. A good feature is the placing at the end the particular enunciations of the propositions with the diagrams placed in positions very different from those which they had in the text: this would enable a pupil to test his acquaintance with the subject. R. T.

Das kleine botanische Practicum für Anfänger. Von Dr. Eduard Strasburger. Mit 114 Holzschnitten. (Jena, 1884.)

A BOOK by Prof. Strasburger, entitled "Das botanische Practicum," has recently been reviewed in NATURE, and recognised as a most valuable addition to botanical literature. The same author has now produced a condensed edition of the same book under the heading given above. The more important of the facts distributed through the 600 pages of the first and larger edition are here collected into the smaller space of 250 pages, an arrangement which is obviously better suited to beginners. It was specially remarked in the review of the larger edition that the efficient study of the various types named would occupy the average student a longer time than the author of the book appeared to think. This smaller edition will obviate the difficulty by supplying the elementary student with a shorter course of study, while the larger book will no doubt be found more useful as a book of reference for more advanced students, or as providing a curriculum for those who will make botany their profession. The merits of good type and excellent illustrations are to be found in this smaller book in as high a degree as in the earlier and larger edition. F. O. B.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Dr. Koch and the Comma-Bacterium

THE article published in NATURE of December 4, setting forth Dr. Koch's well-known theories with regard to the connection of a comma-shaped micro-organism with cholera, serves very efficiently as the text for one who desires to point out the deficiencies in Dr. Koch's observations and reasonings on this subject. The article is the most favourable statement which can be made on the side of those who accept Dr. Koch's conclusions, and is to a certain extent not quite fair to his opponents, since his original statements are not clearly separated from the subsequent statements which he has made in reply to criticisms.

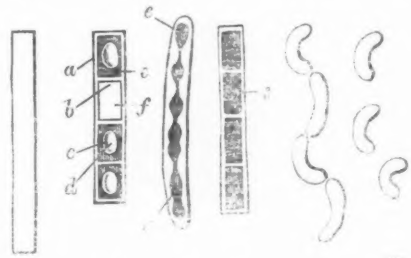
In opposing Dr. Koch's conclusions, it is desirable at the very first to state clearly that those who accept them appear to labour under two important misconceptions, the first being that Dr. Koch is, and has been for a long time, acquainted with *every* form (and the complete history of every form) of Schizomycetes or Bacteria existing, whether in the healthy body or in disease,

or in non-parasitic conditions; the second being that no one, with the exception of Dr. Koch and one or two of his pupils, has any real first-hand knowledge of Bacteria which is of any moment. It is hardly necessary to insist in the pages of a scientific journal upon the fact that these really are misconceptions. Our knowledge of the Bacteria is in its infancy—and Dr. Koch's knowledge of them is no more than that which an industrious worker may be expected to have gained in the course of very special observations in regard to a limited class of these organisms (the pathogenic class) extending over a few years. On the other hand, the study of Bacteria has been prosecuted from three separate points of view during the past fifteen years by a number of observers, who may be grouped according to their point of view as the botanists, the chemists, and the pathologists. It is undeniably the fact that neither the chemists nor the pathologists have given much heed to the work of the botanists, and that the results attained by the three groups of workers have not been brought into harmony. To the medical world the special investigations of the pathologists alone are familiar, and undue weight has been given on the one hand to generalisations which ignore the more widely-based conclusions of the botanists, and on the other hand to the introduction into the pathological arena of methods of study which are not new or original, but have been borrowed from the botanists, whose opinions are nevertheless ignored or dismissed with little consideration. As examples of these tendencies I may quote the reiterated assertion by Dr. Koch, and the pathological school, of the conclusion (upon which they base many very momentous arguments) that the forms and the activities of Bacteria are absolutely fixed and limited—that micrococci only produce micrococci, bacilli only bacilli, spirilla only spirilla, and that none of these forms vary from generation to generation, or can be produced from another of these forms, and that a micro-organism producing a particular disease or a particular ferment cannot in the course of generations lose the property of producing that disease or that ferment, and *vice versâ* that one not having such properties cannot, in the course of human experience, acquire them. This axiom of the pathologists as to fixity of form and property, is entirely opposed to the conclusions of the botanists, who reason from a much larger area of observation. Such authorities as Nägeli, Cienkowski, and de Bary are amongst those who maintain, in opposition to the pathological specialists, that wide range of form and wide range of physiological activity are possible in one species or "race" of Bacteria. To this subject I propose to revert in detail, on a subsequent occasion. As an example of the borrowing of methods by pathologists from botanists, I may quote the fact that it is customary in the writings of pathologists to attribute the gelatine method of cultivation to Dr. Koch, and to attach some additional weight to his conclusions on the ground that he has originated this and other ingenious methods of research. As a matter of fact, the gelatine method of cultivation, which is only a modification of the potato-slice method, is due to the botanist Brefeld (as acknowledged by Koch himself).

Whilst it appears that there has not been on the part of the pathologists engaged in the investigation of Bacteria such an acquaintance with, and appreciation of, the work of the botanists as would be conducive to sound conclusions, it is true that the chemists also have frequently failed in the same way. Much of the work of M. Pasteur on Bacteria is difficult, if not impossible, to verify or to use in any way, on account of the fact that he has not, in prosecuting his studies on these minute plants, made correct use of the conceptions and terminology of the botanists, and has on the other hand used that terminology erroneously and in a special sense.

Dr. Koch has given a very remarkable proof of the isolation of his knowledge and work from that of the botanists (among whom without question the most trustworthy conclusions in this department of knowledge are likely to be found) by his use of the term "spore" in his description of the tubercle-bacillus discovered by him. The "spore" of a bacillus, as shown more especially by the minute studies of the botanist Oscar Brefeld, is a very special structure formed within the filament of the bacillus by a modification of a *part* of its protoplasm, and provided with its own special capsule. Koch actually describes the whole of the constituent protoplasm of a tubercle-bacillus which has a moniliform arrangement as a series of "spores," although it is quite clear that there is nothing in common between the arrangement of the entire protoplasm of a bacillus in the form of a string of micrococci and the periodic and special elaboration of the spores of the hay and anthrax bacilli. The so-called "spores" of the tubercle-bacillus are spores only in the sense that all segments of bacteria which can be detached and multiply are spores (Arthrosporeæ of de Bary) and do not justify the distinction which Koch makes when he states that the tubercle-bacillus is characterised by producing spores, whilst stating that spirilla, such as the spirillum of relapsing fever (which breaks up into segments capable of growth), do not produce spores.

Bearing in mind these facts as to the attitude of different schools of bacteriologists, let us examine the claim put forward



A B C D E F

A. Outline of the bacillus of glanders (which Koch says resembles the comma F). B, Diagram of *Bacillus subtilis* of hay infusion during sporulation: *a*, sheath of the bacillus; *b*, transverse septum; *c*, coat of a spore; *d*, content of a spore; *e*, protoplasm surrounding the spore, which disappears entirely when the latter is fully formed; *f*, empty or sterile segment. C, Tubercle bacillus; the protoplasm is arranged in moniliform masses (*e*), which are erroneously called "spores" by Koch D, Diagram of hay bacillus in vegetative state; the protoplasm is arranged in block-like masses (*e*), comparable to the moniliform masses of C. E, Spirillum dividing into commas. F, Commas (stated by Koch to be identical in form with the glanders bacillus, fig. A).

by Dr. Koch, and on behalf of Dr. Koch, by the writer in NATURE of December 4, p. 97, to have discovered that a certain comma-shaped bacterium is the cause of cholera The writer in NATURE gives a summary of the various peculiarities of growth, form, and properties which Dr. Koch states he observed to be characteristic of a micro-organism occurring in the intestine of persons dead of cholera. He then observes: "Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli." To this conclusion, it is quite impossible in our present state of knowledge to assent. Its acceptance by the writer of December 4 renders it improbable that he will ever be convinced that Dr. Koch has formed an erroneous conclusion. The pretension put forward on behalf of Dr. Koch amounts to this, viz., that he has ascertained all the properties of this organism, that he cannot possibly have made any mistake, and that it is more probable that this organism has, since Dr. Koch left India, disappeared from existence, and been replaced by another very much like it, but not quite the same, than that any subsequent observer should be able to correct the hurried observations made by Dr. Koch when he was there. Such a pretension, were it advanced in regard to an animal or plant belonging to a group of exceedingly well-defined and highly-organised species would be unreasonable, but when put forward in relation to a representative of a group consisting of such minute, unstable, protean, and ill-understood species as are the Bacteria, must lead us to question altogether the impartiality and critical faculty of those who make it.

Admitting, however, for a moment that Dr. Koch's comma-bacillus is as peculiar as he supposes, admitting, as Dr. Koch originally implied by his silence as to the existence of other comma-shaped bacteria, that it is utterly unlike anything at present known in shape as well as in its action on gelatine, Dr. Koch has not proved or even rendered it greatly probable that this comma-bacillus is the cause of cholera, even when we accept his statement that "he has always found the comma-bacilli constantly accompanying cholera, and that he has never found them elsewhere." In the first place, it is quite certain both from Dr. Koch's reports and from the observations of others, that cases of cholera occur in which these commas are not abundant, in fact are insignificant in quantity; and in

the second place, great as has been Dr. Koch's activity in the study of Bacteria, the fact that he and others with whom he is in relation have not found the "comma-bacilli" elsewhere does not render it at all improbable that other observers might find them elsewhere. This fallacy, viz., as to the perfection of Dr. Koch's knowledge of all possible forms and modes of occurrence of Bacteria, I have already pointed out above.

On the supposition that these comma-bacilli *never* occur except in the choleraic process it is of course impossible to maintain (see the article in NATURE of December 4, section (7), p. 98) that the choleraic process merely favours the growth of the commas. But Dr. Koch admits that they occur and flourish outside the human body, in immediate connection with cholera dejecta; also that, when artificially cultivated, they flourish on substances not derived from the human intestine. What proof is there that they do not naturally continue so to flourish? Dr. Koch offers none—he merely tells us that he has failed to show that they do. It is not at all impossible, on Dr. Koch's own showing, that they do—and if they do, what becomes of the argument as to the impossibility of their introduction from external non-choleraic conditions into the human body?

The suggestion is also considered by Koch (and is cited in the section of the article already mentioned) that, "as a result of the disease (cholera), conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli." But, say Koch and his English disciple, there is no evidence of such rapid transformation of one form of bacterium into another. Here we meet with the special axiom of the pathologists to which I have already referred. The opinion of those who are entitled to the very greatest consideration, namely, the botanists Nägeli, Cienkowski, and de Bary, is that there IS evidence of such rapid transformation of one form of bacterium into another. Without going further than the case cited by the writer in NATURE as "merely" an alteration in pathogenic action, we have the instance of the attenuation of the virulence of anthrax bacilli, and we have also the case of the complete change of form of that same bacillus into nostocoid chains of spherical elements when cultivated on pork broth as shown by Klein. These two cases are by no means isolated ones (see my own researches on *Bacterium rubescens*, and also those of Zopf), but were they so they would be sufficient to establish the possibility of such changes in other Bacteria and to destroy the argument based on the assumption that such change is impossible.

The "only conclusion which remains" (see paragraph (*c*), section (7), in the article referred to) is therefore NOT that these bacilli and the cholera processes stand in the relation to each other that the commas are cause and the cholera effect. On the contrary, the only conclusion which remains is that WE DO NOT KNOW whether the commas although not detected by Koch may not be present in some parts of the healthy body, or flourishing outside it on organic matter, or may be the result of the transformation of some other bacterium, or may be the cause of cholera.

And the only way in which that ignorance can be removed has been very clearly recognised by Dr. Koch and all other recent writers, previous to the attempt made by Koch in 1884 to persuade the medical and scientific world that he had discovered the cause of cholera. The obscurity and uncertainty surrounding the Bacteria is such that no value can be attached to any asserted connection of a micro-organism with a disease as the cause of that disease, which is not based upon the experimental production of the disease by the inoculation into healthy animals of "pure cultures" of the suspected micro-organism. Dr. Koch's earlier statements on this subject are so precise and apt that I cannot do better than quote them here. He says in a pamphlet published in 1882, entitled "Ueber die Milzbrandimpfung":—

"The position which I take up is briefly as follows:—It is not yet proved that all infectious diseases are caused by parasitic micro-organisms, and consequently in each particular disease the proof of the parasitic character of the disease must be furnished. The first step towards this proof consists in the careful investigation of all those parts of the body affected by the disease, in order to establish the presence of the parasites, their distribution in the diseased organs, and their relation to the tissues of the body. . . . It is not until a thorough knowledge has been obtained in this way as to whether micro-organisms are present in the diseased parts, at what points they are present in perfect purity—whether, for instance, in the lungs, spleen, heart's blood, or elsewhere—that the attempt can be made to obtain the proof that these micro-organisms are of a pathogenic nature, and that they are more especially the cause of the disease in question. With this object in view, they must be isolated by means of 'pure cultivation,' and when they have been freed in this manner from all particles of the diseased body originally adhering to them they must be introduced by inoculation into the same species of animal in which the disease was observed, or, if that should not be possible, into animals in which the disease in question is known to occur with unmistakable symptoms. . . . An example is afforded by the disease known in man as erysipelas. It has been known for a long time that in this disease micrococci constantly are found in the lymph-vessels of the skin. *But by this knowledge it certainly was not proved that the micrococci are the cause of erysipelas.* Now, however, that Fehleisen has recently succeeded by excision of portions of skin from erysipelas patients (with every precaution against contamination by other bacteria which might be accidentally present on the skin) in rearing these micrococci in 'pure cultivations,' and in producing typical erysipelas by inoculating the human subject with these isolated micrococci, there can no longer be any doubt that the micrococci are, in fact, the cause of erysipelas, and that the latter is to be regarded as a parasitic disease."

This is the kind of proof which we require in the case of the comma-bacillus, and its supposed causal relationship to cholera. Dr. Koch has not succeeded in obtaining that proof. He has tried, and has failed, to produce cholera by inoculation of "pure cultivations" of his "comma." Cholera, at present, is not known as a disease in animals. Nevertheless, Dr. Koch has urgently and persistently declared that he considers it to be proved that the comma-bacillus is the cause of cholera! After repeated and public declarations of this conclusion, he is now making experiments by introducing his "comma-bacillus," not through the mouth, but by fistulæ into the intestine of rodents. Those who know the history of experiments on the production of cholera in mice and other rodents will not be convinced, even should Dr. Koch succeed in producing choleraic symptoms in this manner, since the readiness with which cholera-like processes are induced in these animals by abnormal conditions is such as to render them unfit subjects for these researches.

II. We may now revert to some of the statements made by Dr. Koch, which in the preceding remarks we have accepted without criticism. Even when this method is pursued, we find Dr. Koch's conclusions unwarrantable; they will appear still more so when we examine his position in detail. The writer of the article in NATURE of December 4 has omitted to notice a very important charge brought by Dr. Lewis against Dr. Koch, after the publication of Dr. Koch's address to the Medical Conference at Berlin in last August. Dr. Koch, also, has remained entirely silent in regard to this matter. It would be a very important thing if he would even now frankly reply to it. Dr. Koch and his defender assert that the "comma-bacilli" were found by Dr. Koch in cholera cases in Egypt, and also in specimens of intestine sent to him from India previous to his going there. Dr. Timothy Lewis, on the other hand, asserts that Dr. Koch had *not* recognised the "comma-bacillus" previously to his visit to India, and that in Egypt Dr. Koch attributed the causing of cholera to a totally different organism from that which he put forward after his arrival in India, and that, although he had thus shifted his ground, Dr. Koch did not admit at the time, and has not since admitted, that he was at one time convinced that cholera was caused by one organism, and a few months after was convinced that it was caused by another.

This charge is of importance for two reasons. If true, it must tend to lessen the confidence reposed by some in Dr. Koch's conclusions; and, secondly, it must also lessen our belief in the candour with which he states all the circumstances attending his observations and inferences.

The following quotations from the official reports sent home at intervals by Dr. Koch, coupled with the fact that he has not replied to Dr. Lewis on this point, though he has replied to him on other points, seems to leave little room for doubt that Dr. Lewis is perfectly correct in the very grave charge which he has brought against Dr. Koch.

In his report from Alexandria, September 17, 1883, Dr. Koch says:—"These bacteria are rod-shaped, and belong accordingly to the genus bacillus; they resemble most nearly in size and form the bacilli found in glanders" (which are straight: see woodcut, fig. A). In his report from Calcutta, dated January 9, 1884, he says:—"The microscopic examination demonstrated the presence of the same bacilli in the cholera intestine as had been found in Egypt." In a further report, dated February 2,

1884, we at last get the following remarkable statement:—"The bacilli are not quite rectilinear, like other bacilli, but slightly curved, like a comma. The curvature is sometimes sufficient to give the bacillus a semicircular form" (see woodcut, fig. F).

I think that it is abundantly clear that the organism selected by Dr. Koch in Egypt as the cause of cholera is not the same organism as that which he selected when in India, and that, although he is aware of that fact, he has not explicitly stated it, but has on the contrary (as does the writer in NATURE) endeavoured to give the impression that they are the same organism.

A further point of great importance as affecting the validity of Dr. Koch's theories, with regard to the connection of what he calls the comma-bacillus with cholera, is the statement of Dr. Lewis which is abundantly confirmed, and is not disputed by Koch, viz. that comma-bacilli, indistinguishable in appearance from those occurring in cholera cases, are quite common in the mouths of healthy persons. There is no doubt whatever that this is the case, although no record of the fact is to be found in any published treatise or paper on Bacteria, and that it was not commonly known to bacteriologists previously to Dr. Lewis's announcement of it in last September. The writer of the article in NATURE of December 4 hardly gives full effect to the importance of this point, since he cites Dr. Koch's reply to Dr. Lewis at the same time that he records Dr. Koch's earlier statements. Setting aside for the moment Dr. Koch's reply to Dr. Lewis, let us examine Dr. Koch's statements bearing on this subject, at the time when he announced his supposed discovery of the cause of cholera. He wrote from India that the organisms which he identified as the cause of cholera were of *peculiar* form, and "on account of its peculiar form, I have given to it the name of comma-bacillus." Throughout his subsequent writings, previous to the publication of Dr. Lewis's report by the Army Medical Department, Dr. Koch speaks of his cholera-organism as *the* comma-bacillus. He does not mention that any micro-organism similar to it in form is known to him. Had he been acquainted with one commonly occurring in the mouth, he would certainly have said, "The cholera comma is very like one occurring in the mouth, but differs in such and such ways." So far from this, he expressly says that no similar organism occurs in the human body, and states that he has failed to find an organism like the comma-bacillus in (amongst other places) the human mouth. No subsequent statement (after Lewis's publication) can affect the evidence which we have here that Dr. Koch was not acquainted with the "comma" which occurs in the human mouth.

After Dr. Lewis had shown that a "comma-bacillus" indistinguishable from Koch's "comma-bacillus" occurs in the healthy human mouth, and that accordingly—if we may suppose, from their identity of form and close association, that the two organisms are identical in every respect—the fundamental proposition of Koch as to the exclusive association of his comma-bacillus with cholera utterly breaks down, Dr. Koch replied as follows—(1) that the occurrence of a comma-bacillus in the mouth had long been familiar to bacteriologists (he did not say, it is to be noted, that it had long been familiar to him); and (2) that this comma-bacillus of the mouth will not grow upon neutralised cultivating-gelatine, whereas that from the intestine will, and that accordingly there is no ground for regarding them as identical species.

It seems to me in the highest degree improbable that Dr. Koch was acquainted with the mouth-comma when he published his conclusions as to the cause of cholera. If he was acquainted with it, it is undeniable that he committed a very grave fault in not drawing attention to it, and pointing out then and there the differences presented by cultures of the two commas. I have fairly conclusive evidence before me of the fact that Dr. Koch was not acquainted with the comma-bacillus of the mouth two years ago, when he published his large report and coloured plates on the tubercle-bacillus. In one of the drawings in that work he gives a delineation of the chief forms of micro-organisms occurring in the mouth, in order as he says to enable other observers to guard themselves against any confusion of the tubercle-bacillus with the micro organisms which are normally present in sputa. *No comma-like organism is figured in that drawing or mentioned by Dr. Koch.*

As to the cultures of the "comma" from cholera intestines on the one hand, and from the healthy mouth on the other, differing in respect of their properties or their sensitiveness to conditions of alkalinity and neutrality, I venture to say that, *taking into consideration the whole history of the case*, it is not sufficient for Dr. Koch to tell us in an abrupt way that such differences exist. There is no reason to accept as final and perfect Dr. Koch's account of the characters of the comma associated with cholera, and I should greatly prefer to have the comparison of the conditions of growth of the commas from these two sources made by some one who is not, as Dr. Koch must unfortunately be, so very seriously biased in one direction.

I think there is some reason to expect that we shall hear from Dr. Klein as to the result of his impartial experiments, now being carried on in Calcutta, that the comma which occurs in the healthy mouth behaves in precisely the same way under cultivation, and is in fact as in appearance the same organism as the comma which occurs in the intestines of cholera patients.

Lastly, I may record a protest against Dr. Koch's extraordinary term "comma-bacillus." I have already pointed out that Dr. Koch uses botanical terminology loosely. The word "bacillus" has been by common consent restricted to the description of such rod-like forms as Koch first associated with cholera as the result of his Egyptian work. To prefix the word "comma" to this, was perhaps a method of avoiding unpalatable explanations. At the same time it is utterly inconsistent with the sense of the words. What Koch calls "comma-bacilli" may for convenience be termed "commas." They are well known to botanists as the segments of a spirillum (see woodcut, fig. E), the result of the breaking up of a spirillum into little pieces, one corresponding to each turn of the spire. They have been clearly figured and their nature recognised by Zopf. The "commas" of the human mouth and intestine are undoubtedly related to a spirillum which is frequently found in association with them, and would not have caused any astonishment or been stigmatised as "peculiar" in form by an observer who had that adequate knowledge of the natural history of the Schizomycetes in general which Dr. Koch has in many ways shown that he does not possess.

E. RAY LANKESTER

[We desire merely to make one remark with regard to the foregoing letter. The article referred to was prepared at the request of the Editor with the view of putting before the scientific public a fair and complete statement of Dr. Koch's case. The writer of the article requests us to state that he did not, except in the last paragraph, give any views of his own, and holds himself perfectly neutral in the matter, his mind not being at all made up on the subject.—ED.]

On the Distribution of Honey-Glands in Pitchered Insectivorous Plants

THE four genera of pitchered insectivorous plants at present in general cultivation are Nepenthes, Sarracenia, Darlingtonia, and Cephalotus. Attention was drawn to the minute structure and physiological action of the first three of these by Sir J. Hooker in his celebrated presidential address to the British Association in 1874, while the structure and morphology of the last was treated of by my master, Prof. Dickson (*Journal of Botany*, 1878, 1881). Both observers pointed out an *attractive surface* studded with honey-glands, which constituted the lid part, a *conducting surface*, either of an exceedingly smooth nature (Nepenthes), or beset with small downward-directed hairs (Sarracenia, Darlingtonia, Cephalotus), and in most cases a *glandular surface* (Nepenthes, *S. purpurea*, and Cephalotus), the secretion from which directly or indirectly assisted in digestion of animal products. In Sarracenia and Darlingtonia there was found in addition a *detentive surface*, covered with long deflected hairs.

A year ago Prof. Dickson further drew attention to a set of magnificent attractive glands along the free edge of the corrugated rim in Nepenthes, which he named "marginal glands."

My attention has recently been directed to all the genera, and I propose stating here the main results. A detailed account of the comparative results obtained by examination of the different species in the young and adult condition will shortly be presented to the Royal Society of Edinburgh.

Nepenthes.—Examining a pitcher of Veitch's beautiful hybrid, *N. Mastersiana*, I observed on its outer surface what seemed to be the small openings of honey-glands. When microscopically examined, they were found exactly to resemble those on the inner lid surface, except that the gland fossa was deeply hollowed out, and opened externally by a small orifice, while its inner surface was clothed to within a short distance of the orifice

by the gland tissue, very much as in sphæriaceous fungi the cavity of the perithecium is lined by asci. But even in this they agreed with the lid glands noticed by Dickson in *N. lævis*, and termed by him "perithecioid." Careful study of the outer lid surface revealed a few similar glands. On comparison of the species and hybrids grown in the Royal Botanic Garden, Edinburgh, a like condition was found to occur in all. The presence of these on the outer pitcher surface of *N. ampullaria* is interesting, since in it the lid is rudimentary, directed back, and destitute of glands on its inner surface.

At Prof. Dickson's suggestion I then examined the expanded lamina, and was agreeably surprised to find that glands were scattered rather sparingly over its upper, but pretty abundantly over its under, surface, especially near its junction with the stem. The tendril intervening between the lamina and pitcher also possessed them, and in some cases they were of very large size. Passing to the stem, it was found that some species had them very sparingly, others in considerable number, but while resembling those on the leaf externally, they were sunk much deeper in the tissue of the cellular layer, and strikingly reminded one of a simple animal gland.

After a comparative study of the different species I was induced to look at the sepals, as our garden curator, Mr. Lindsay, had mentioned to me that a very copious secretion of nectar took place in flowering. A complete pavement of glands the same in size and appearance as those on the inner lid surface of the pitcher, was spread over the upper epidermis of each. In Hooker's elaborate monograph of the genus ("De Cand. Prod.," vol. xvii.) these are mentioned, though their complete resemblance to the latter is not indicated. A few large "peritheicoid" glands may also be seen on the lower epidermis, and in flowers of *N. bicalcarata* (for opportunity of examining which I am indebted to Mr. Courtauld of Braintree), these attain relatively a gigantic size.

We see, therefore, that in Nepenthes, with its diœcious flowers, the same structure, which by their secretion attract insects for aiding in fertilisation, also lure them to the pitcher, so that their dead bodies may help in the nutrition of the plant.

Sarracenia.—Mellichamp pointed out (*Gardener's Chronicle*, 1874) that honey-glands are present not only on the lid, but also on the external projecting wing of the pitcher. I find, however, that, as in the last genus, they are diffused over the whole outer surface, including the lid; further, that in some of the species (*S. variolaris* and *S. rubra*) there are external upward directed hairs, as in some of the Nepenthes. On the outer surface of the three bracteoles and of the sepals the glands are likewise numerous, and will undoubtedly be insect attractors for promoting cross-fertilisation.

Darlingtonia.—This genus agrees with the last, except that the glands are very simple, being one- or at most two-celled. I have not as yet examined the flower, though there can be little doubt but that in it a like condition will occur.

Cephalotus.—Prof. Dickson, in studying this genus, noticed glands not only on the lid and outer pitcher surface, but even on the ordinary foliage leaves. I therefore required to deal only with the flowers. Scattered among the "encapsulating" hairs on the peduncle, bracts, and six sepals, were many glands identical with those of the leaves, though rather smaller; but further, the peculiar glandular processes intervening between the stamens and carpels seem to be the same mounted on cellular outgrowths of the receptacle.

Nepenthes, Sarracenia, Darlingtonia, and Cephalotus are therefore found to agree fundamentally in their morphological arrangements for physiological purposes, though referable to orders widely separated systematically.

J. M. MACFARLANE

Botanical Laboratory, University of Edinburgh

Earthquakes in England, and their Study

As no record of the most recent earthquake shock in England has yet found a place in the pages of NATURE, perhaps I may be permitted to give the following slight details, collected from the daily papers of Lancashire and London for November 15:—

A shock of earthquake ("severe," yet causing no actual injury) was experienced at Clitheroe, and in the neighbourhood, on the evening of November 14. At about 5.10 p.m. a terrific report, resembling loud thunder, was heard, instantly followed by a strong vibration of the earth, sufficient to induce the inhabitants to run out of their houses into the streets in a terrified state.

At Low Moor, where the shock seems to have been felt most strongly, the wife of a man named Wilkinson fainted with fright. A waggoner on the road states that his two horses were nearly thrown to the ground. Much excitement prevailed throughout the borough and neighbourhood of Clitheroe, especially at Low Moor.

A lurid glare noticed in the sky at the time of the disturbance —5.10 p.m., sun set at 4.10—is mentioned in connection with the occurrence, but that appearance was, in all probability, only one of the sunset-glow effects with which we have lately become so familiar, and had nothing to do with the shock.

The circumstance that this particular part of Lancashire is much subject to earthquake disturbances, makes it specially important that no details of their occurrence be lost to science. Within the last fifty years at least six well-authenticated shocks have been recorded,—in 1835, 1843, 1868, 1871, 1873, and 1884,—and this list might easily be extended. Lancashire, indeed, may be considered as one of the chief areas of disturbance in England, and after Comrie, in Perthshire, perhaps the most important centre of seismic action in Great Britain.

While writing upon this subject, perhaps I may be allowed to offer the suggestion that, as the study of seismology is now one of such growing importance, it would be of considerable interest to many if a small space were set apart in the columns of NATURE every month, devoted specially to the record of current earthquake action, and kindred convulsions, in a scientific manner. It is my experience, as one who has for some time been engaged in collecting certain facts of these phenomena from various sources, that no sufficiently precise and complete records of the necessary facts, as may thus be readily transferred to the annals of exact science, are anywhere available. The general observations of seismic disturbance as heretofore described, are usually not only scanty in the matter of their detail, and often dressed up still with a superstitious flavouring, but also, for lack of *the right class* of observation, are too frequently merely vague and useless statements of wrong facts, generally in favour of doubtful hypotheses; and these are allowed to take the place of a well-ordered treatment of the real state of the case, upon a proper scientific basis.

WILLIAM WHITE

55, Highbury Hill, N., December 9

The Cacao-Bug of Ceylon

THE note by Mr. Distant in your number for October 30 (p. 684) may perhaps lead its readers to think that the insect which has lately been the subject of a report to the Ceylon Government has been wrongly identified by me as *Helopeltis antonii*, Sign. As that report will, however, before this have reached England, the matter will probably have been set right. I am not an entomologist, nor have I here the opportunity of reference to Signoret's original description or to other descriptive works; but the insect is, without any doubt at all, that which is well known—too well known—in Assam and in Java as *Helopeltis*. In the former country it is the destructive tea-bug or "mosquito-blight,"[1] and in the latter it is the notorious pest of the cinchona plantations.

As to the fragments which reached Mr. Distant, they were apparently insufficient for identification, further than with the family *Reduviidæ*. The cacao-tree harbours a host of Hemiptera, and planters are very apt to confound the innocent with the guilty. Its only formidable enemy in this order of insects, however, so far as I have seen, is the *Helopeltis*.

HENRY TRIMEN

Royal Botanic Garden, Peradeniya, Ceylon, November 21

The "Messenger of Mathematics"

I THINK it is right that attention should be publicly directed to the exceedingly irregular appearance of the *Messenger of Mathematics*. In the case of a magazine of its size and character there is no reason whatever why it should not be published on the first of each month. The "heavy" mathematical journals may be permitted to turn up when their editors please; but the case of a *monthly* meant to foster a taste for mathematical investigation among junior mathematicians is entirely different; indeed, the good such a magazine is calculated to do is almost nullified by irregular publication. The *Messenger* is always

[1] Since my report was written, Mr. Wood-Mason's short treatise on the tea-bug has reached us here.

more or less irregular: just now, however, it is drawing so long a breath that one fears that its last message has been carried. We are now in the middle of December and the *October* number has not yet been heard of! ANGELUS

The Pronunciation of Chinese Names

SOMEWHAT after date, I beg to return to the subject of Anglo- and Franco-Chinese orthography, referred to in NATURE, vol. xxx. p. 592. In a short paper of mine published in the *Proceedings* of the Royal Geographical Society, vol. xxii. No. 6, 1877, I alluded to the desirability of a uniform or fixed "Roman equivalent" for Chinese characters standing for names of places, &c. I inclose a copy of this paper for insertion if desirable. To my mind the Italian vowels, &c., come nearest to the sounds of the Chinese characters. *Tung-King*, meaning "Eastern Capital," is the usually accepted form of *Tonquin*, or *Ton-Kin*, the terminal *g* being but slightly sounded. *Shang-hai*, the "Upper Sea," or the place "of going up to the sea," should be pronounced with the *g*, and is so spoken (Shanghai) by English and American authorities. Dr. Wells Williams has, I believe, in manuscript a standard Chinese Gazetteer of the World, in which all proper names likely to be used in telegraphy, newspapers, &c., are smoothly transliterated into Chinese characters. For translations from Chinese it is very necessary to adopt some such plan as Dr. Hunter has suggested for Indian names. Although his plan has come too late into the field to induce people to spell Calcutta as Kolkata, this is hardly the case as yet with Chinese names. The old native names of places should always be literally preserved. How much more beautiful is the old Franco-Indian name Stadaconda than Quebec for the scene of the death of Wolfe! I should be glad to co-operate or correspond with any interested in this matter, so prominent and important at the present juncture. F. PORTER SMITH

Hillworth House, Shepton Mallet, December 12

EXPLORATIONS IN ICELAND[1]

THE LAVA DESERT OF ÓDÁÐAHRAUN

III.

THE second part of my programme included the exploration of the western and southern portions of the Ódáðahraun Desert. In this journey I spent a fortnight during the latter half of August, a thoroughly rough and arduous time, on account of the very unsettled weather alternating between cold and rain, tempestuous gales, snowstorms, and sand-hurricanes. My journey extended to 240 English miles, but only two oases of grass were discovered the whole way. Along the skirts of Vatnajökul, throughout the whole extent of the lavas and sand plateaus which form the northern fringe or border intersecting it from Ódáðahraun, not one single blade of grass, nay, not even signs of mosses or lichens, are anywhere discoverable, hence we were obliged to provide ourselves with fodder for the horses in the shape of hay, oats, and maize dough.

The results of the journey are in every way as good as, under the circumstances, I could have anticipated. Now at last the whole of Ódáðahraun, with its surrounding wildernesses, has been explored. The weather was often enough sufficiently clear and fair to give me an opportunity to note all that required surveying The few who have travelled over various parts of these deserts before me have seen next to nothing, on account of bad weather. Ódáðahraun, as stated in a former letter, is the largest lava-desert not only in Iceland, but in all Europe; the main portion of it has been formed by volcanic activity in Iceland in prehistoric times; but since the discovery of the island, even down to our own day, the region has witnessed a succession of eruptions. The various lava flats form one plateau, the bounds of which are determined on the east by Jökulsá in Axarfjörd, south by Vatnajökul, west by Skjálfandafljót, north by Mývatn. At its southern extremity it rises to 3200, at its northern to from 1400 to 1500, feet above the level of the sea. Altogether I took there about two hundred barometric and trigonometrical elevations and surveys. The separate lava-flats are due to about twenty separate volcanoes, honeycombed by hundreds of craters. Several of the separate lavas are, to the extent of many tens of square miles, one unbroken flat lava-field as it were; others, again, all torn up and disrupted, in some cases almost, in others entirely, impassable. The substratum of Ódáðahraun is palagonite-tuff and breccia, over the top of which is spread the doleritic lava, the origin of which dates from before the Glacial period. Above all the modern lavas have flowed. All the mountains that tower above the lava consist of palagonite breccia; along their roots and spurs are frequently found rows of craters, as well as those shield-fashioned volcanoes from which the lavas have welled out. The largest volcanoes have been built up entirely by lava-floods, which have flowed successively over each other, so as to form enormous convexities presenting an equal inclination to every side, but so slight as to amount to only a few degrees. This kind of volcano, which in the north country is generally designated by the name of Dyngja, reaches in Iceland nowhere such dimensions as in Ódáðahraun, as for instance Kollótta-Dyngja, Trölladyngja, Kerlingar-Dyngja, Ketil-Dyngja. In some places many rows of craters are ranged together along rifts from north-east to south-west, as on Reykjanes, and in Dyngjufjöll, where the craters around Askja and along the slopes of the mountains are practically innumerable. In Ódáðahraun proper hardly any water is found; rain sinks through the lava, and emerges again from under its edges in many small rivers and springs. The southernmost portion of Ódáðahraun has already been buried under glacial mud and sand from Vatnajökul, incessantly poured over its edge towards the north by innumerable glacial rivulets, that mostly vanish into the underlying sands and the lavas over which they are spread. Some of the larger streams, however, find their way eastward to Jökulsá in Axarfjörd, and a few into Skjálfandafljót. In consequence of the elevation of Ódáðahraun above the level of the sea, and of its waterless condition, it is a region almost barren of vegetation. On the drift-sand a few tufts of *Elymus arenarius* or stray specimens of *Statice armeria* and *Cerastium alpinum* may be found. Round the skirts of Ódáðahraun, where the water wells forth, a good deal of vegetation shows in some places, especially along the western fringes, in the valleys of Skjálfandafljót, where summer-pastures form the sheep-walks of the inhabitants of Bárðardal. On the eastern side of Ódáðahraun there are only two oases—Herðubreiðarlindir and Hvannalindir, and here the vegetation is confined to the banks of springs, its most distinguishing feature being the *Angelica archangelica*, which grows in small clusters or bushes everywhere along the banks of the brooks. There occur likewise some species of the slighter kinds of willow, such as *Salix glauca*, *S. phyllicifolia*, *S. herbacea*, as well as a few species of heather. Over the watered shingle-flats about Herðubreiðarlindir there are spread in parts red carpets of the lovely French willow-herb (*Epilobium angustifolium*). Insect life is very poorly represented, hardly anything being visible, save a few *Diptera*. To the south of Ódáðahraun not a plot of grass is to be seen, except at Gæsavötn, in Vonarskarð, where the vegetation is of the scantiest kind, comprising indeed little more than the *Salix herbacea*. Along glacial streams no sign of vegetation is ever apparent here; what little occurs grows along fresh-water springs.

It might be imagined that such a volcanic region as Ódáðahraun would be rich in hot springs, solfataras, &c. But such is not the case. The main portion of the lava is now so old, that all such volcanic phenomena seem to have died out. Of warm springs only two may be said to be still in existence, both on the western side of the lava; yet they are only lukewarm (respectively $33\frac{1}{3}^\circ$ and $35\frac{1}{2}^\circ$ C.) About Gæsavötn such springs obviously once

[1] Continued from vol. xxx. p. 585.

exited, but they have now almost entirely vanished (their temperature having sunk to from 5° to 7° C). Dyngjufjöll, especially the valley of Askja, are the only localities in these regions, where volcanic manifestations of this character are now to be seen; and there hot springs, clay-pits, sulphur-mines, and fumaroles of every kind are well developed. But these appearances are to be connected with an enormous eruption which occurred as late as 1875. Throughout the whole of Ódáðahraun I have come upon no traces of subterranean heat, except at the places here mentioned. About the peninsula of Reykjanes which I explored last year, many more signs of activity were found, which seems to show that in that locality the volcanic disturbances are to be referred to a later period than those of Ódáðahraun.

The northern edge of Vatnajökul has never been examined before. In my journey I was enabled to take the various elevations of this glacier, and found that at its western extremity, in the neighbourhood of Vonarskarð, it rises to its greatest height, over 6000 feet. East of this point it becomes lower, until it rises again about Kverkfjöll, where an upheaval is perceptible right across it from north to south. From the hollow, or lowest point, the largest glacier in Iceland has taken its course. It is important that this glacier should be carefully examined, but its exploration would require a long time, for it is almost impossible to make a lengthened stay here, on account of the utter barrenness of the region, and the roughness of the weather.

In this journey I succeeded in solving the geographical riddle, which of the many rivers of Iceland is the longest. It has hitherto been assumed that Jökulsá in Axarfjörd was the longest, 100 English miles; and that next to it came Þjórsá, 96 miles long; but I have now ascertained that Þjórsá is by far the longest river in Iceland, its course being about 120 miles, while Jökulsá is only 95. Hitherto, also, it has been supposed that the sources of Jökulsá were situated in the spurs of Kistufell; they are really twenty miles further to the east, under the western slopes of Kverkfjöll. The sources of Þjórsá are situated in the north-westerly portion of Sprengi andr, to the north-west of Fjórðungsalda. Þjórsá, too, carries a greater volume of water than Jökulsá. On a July day the latter carries, midway between its source and its mouth (viz. at Grímsstaðir) 14,500 cubic feet of water per second, but Þjórsá at the proportionate point (at Þjórsárholt) carries 17,600 cubic feet in the same space of time.

Akreyri, September 7 TH. THORODDSEN

AMERICAN SUMMER ZOOLOGICAL STATIONS

IN the United States there has been during the past ten years a great increase in the advantages for the study of zoology. Not only has this increase been manifested in the colleges, but also by the facilities for summer study at the sea-shore. At present we have on the Atlantic coast five stations where there are facilities for students to carry on investigations. These laboratories are of two kinds—one where only the advanced student is allowed to study, the other in which any one manifesting a sufficient interest in Nature may be allowed a chance to work upon the marine animals; these latter are themselves divisible into two classes—one in which regular instruction is given, and the other where the student is supposed to study for himself under the direction of an efficient instructor.

The laboratory at Beaufort, North Carolina, connected with Johns Hopkins University, is intended as a place where students of the University, and somewhat advanced students from other colleges, can spend the summer in advanced work. It has attained for itself a reputation equalled by no other laboratory of its character in the country, because of the excellence of its work. Being supported by a regular fund, there are advantages connected with it which one will not find in other laboratories which are dependent upon subscriptions. Some excellent specialists spend their summers at this station, and the character of their work is shown in the bulletins published from the laboratory. Although Beaufort is not remarkably rich in variety of forms, still this is counterbalanced by the abundance of certain very interesting animals, for the study of which no better place than Beaufort can be found. As the Gulf Stream strikes on this coast, there are many interesting embryos found in the water. The building is a two storied house made to serve as a laboratory, and it is placed within a few feet of high-water mark. The location is a low sandy shore in a rather warm climate, but this is necessary on that coast where nothing else is found. For collecting purposes a steam-launch and sail-boat are used. It is under the direction of Prof. W. K. Brooks, who has done much towards making it what it now is.

Much further north, at Newport, Rhode Island, is another laboratory of a somewhat different character. It is under the charge of Prof. Alexander Agassiz, who, with a few assistants and some advanced students from Harvard College, carries on his investigations on the sea-shore. Dr. F. Walter Fewkes and C. O. Whitman study regularly at this laboratory. Because of its private character it should rather be classed with the former private laboratories which investigators were accustomed to establish at some favourite place on the sea-shore than with the general laboratories for students, though a certain limited number are admitted each summer. The advantages for study are limited, and the locality rather poor.

In the southern part of Massachusetts, at a place called Wood's Holl, the chief marine station of the United States is stationed. This is the Laboratory of the United States Fish Commission. Since 1871 the Fish Commission has each year been located at some point on the New England coast, investigating principally the specific characters of the marine fauna. Prof. Baird, the Commissioner, has had the direction of the Commission since it was first originated, and with the assistance of such eminent American naturalists as Goode, Bean, Verrill, Smith, and Sanderson Smith, the previously unkown New England fauna has been thoroughly studied, and certain parts of the North Atlantic deep sea carefully studied. For many years all the work has been done by specialists employed by Government, in a poorly adapted laboratory; but now a new building is being erected for the express purpose of serving as a laboratory, and it will be fitted up with all the modern conveniences for zoological and microscopical study. Being supported by an ample Government fund, it is expected that there will be a good library connected with it, and we know that there will be a supply of large aquaria, and that all necessary chemicals will be supplied. In addition to the tables for regular *employées*, there will be room for a limited number of students from some of the larger colleges, who will thus be offered the finest advantages for zoological study to be found in America. For the use of the laboratory there is a steam-launch, and many small boats, while the two steamers *Albatross* and *Fish Hawk* are constantly bringing in material from the deep sea and surface of the ocean. Wood's Holl is excellently adapted for the purposes of a summer laboratory, both because of climate and variety and abundance of animal forms. The work already done from the old laboratory is of world-wide renown.

This ends the list of those laboratories intended solely for advanced students. Of the other class, the Summer Institute at Cottage City, Mass., is an example. This is a summer educational institution covering a wide variety of subjects, and intended for teachers who are willing to

spend their summers in quiet study. Courses of lectures are given in various subjects, one of which is natural history, and the students can, if they choose, supplement their course by laboratory study. It is exceedingly elementary, and none but beginners attend.

Of a similar character, but of more importance, was the Summer School of Natural History at Salem, Mass., under the direction of Prof. E. S. Morse. The principle upon which this school started was wrong. The originators seemed to have the idea that courses of lectures were essential to the success of the school. Such lectures, if delivered by men of reputation, were costly, and to meet the expenses of the school a large attendance was necessary. But in America the sciences are not studied by a sufficient number of people to supply such a school, dealing in a limited branch of science, with enough students to defray the cost of lectures; and few students can afford to pay large tuition fees. So it was that the Salem School had to depend entirely upon outside aid for its continuance, and this being withdrawn, the school was obliged to break up a few years ago. It is, indeed, unfortunate that it was obliged to do this, because it was filling an important place in American scientific education by originating an interest in teachers of the public schools for this branch of study, and thus raising the standard of scientific teaching in the lower schools. If a regular fund could be placed at the disposal of some body of scientific men for the purpose of giving instruction to teachers in this way, it would be an important thing; but unless such regular support be established, other less expensive means of instruction in natural history for beginners must be looked to.

At Annisquam there is another laboratory, under the direction of Prof. Alpheus Hyatt, which has an entirely different plan for teaching beginners. At this laboratory both beginners and advanced students are allowed to study upon paying a merely nominal sum. No special instruction is given, but there is an instructor, Prof. J. B. Van Vleck, who helps the beginner over hard places in his studies. The student is given some animal to make a study of, and he is advised to examine it critically, dissect it, and make drawings of the parts, all without the aid of a book; and then, having found out all he can without aid, he is given some book to verify his observations. In this way the student goes through all the important groups of marine invertebrate animals, often learning for the first time that he can really see things for himself without the aid of books. The powers of observation are brought into play, and the first foundation of a successful student of Nature are thus laid. How much practical benefit this method of instruction will have in making original investigators cannot be told at present, because the school has been in operation for such a short time. The amount of knowledge possessed by the students at the end of the summer, compared with that with which they started, is certainly encouraging. That this is the proper method of teaching natural history has been satisfactorily demonstrated to those in charge by the results. Both sexes are admitted, and preference is given to those who are going to make use of the facts which they learn, either in teaching or in special investigation. The building is a plain one-story-and-a-half house, situated at the water's edge. It is well lighted and firm, and aquaria on each table are furnished with water from a tank filled by a windmill. For collecting purposes there are common boats, and Prof. Hyatt has a schooner yacht, in which he frequently takes parties from the laboratory upon dredging expeditions. Fifteen was the average number of students last summer, and they came from all parts of the country, being mostly teachers in small colleges and schools, and a few medical students and special investigators. In its inception it was intended for beginners, but advanced students are welcomed and given the best tables. The one unfortunate thing about this laboratory is that it is not established on a firm money basis, depending each year upon a grant of money from the Woman's Educational Society of Boston, which each year, so far, has generously given the funds for its maintenance. Neither the director nor the instructor receive salaries for their work, but furnish their summers free to the cause. For the purpose of making collections there is no better place on the eastern coast of the United States, with the exception, perhaps, of Eastport, Maine. The variety of animals is immense, and their abundance is also great, every condition necessary to an extensive fauna being present.

The last laboratory which we shall notice is the one which has long since passed out of active existence, in fact which died with its founder, the elder Agassiz. It was an immense building of wood on the island of Penikese, in Massachusetts, the outermost of the chain known as the Elizabeth Islands. The location was poorly chosen, for the fauna in the vicinity is poor, and there was no regular communication with the mainland, which was twenty miles distant. At one time during its brief existence it had a very large attendance, beginners particularly being attracted by the name of the eminent director. Lectures were given and laboratory practice was allowed each student. At this school such men as Fewkes, Faxon, Brooks, Whitman, and Alexander Agassiz, who have since become eminent in American science, received some of their first instruction in natural history. The death of Agassiz ended the institution, which if it could have been kept up under his direction would no doubt have equalled if not excelled any similar institution in the world. It is doubtful if even under Agassiz's direction this stupendous school could have been carried on, for we understand that the money basis was very insecure, and certainly the expenses were very heavy, and the tuition charges light.

RALPH S. TARR

ON A NEW METHOD FOR THE TEACHING OF SCIENCE IN PUBLIC ELEMENTARY SCHOOLS[1]

THE desirability of imparting to children some knowledge of the principles of science is now so generally agreed upon that this paper will be devoted not to the argument that science-teaching is necessary, but to a description of a method by which it may be successfully and thoroughly carried out.

In the "Code" under which the system of Government education is carried on in this country, science is mentioned under two heads:—

(1) As a "class-subject" (optional) which may be taught to any or all of the seven "Standards" under which the children are classed, and

(2) As a "specific subject" (also optional) which may only be taken by the children in Standards V., VI., and VII. The specific subjects named are—

1. Algebra.
2. Euclid and Mensuration.
3. Mechanics.
4. Latin.
5. French.
6. Animal Physiology.
7. Botany.
8. Principles of Agriculture.
9. Chemistry.
10. Sound, Light, and Heat.
11. Magnetism and Electricity.
12. Domestic Economy (*Girls*).

Either one or two (but not more than two) of these specific subjects may be taken by a child. The course in each subject is divided into three parts, so that a child must remain at school for three years in order to complete the study of any one subject.

The grants paid are at the rate of 1*s.* for a "fair" or 2*s.* for a "good" pass in class-subjects, and 4*s.* per pass in the specific subjects.

[1] By W. Jerome Harrison, F.G.S., Science Demonstrator for the Birmingham School Board. The greater portion of this article was read as a communication to the International Conference on Education, held at the Health Exhibition in July last, and is here reprinted by permission of the Executive Council.

To be successful in a public elementary school any scheme of instruction must be based upon the conditions of the Code. To these conditions, as they now stand, the following exceptions may be taken:—

(*a*) The teacher is forced to choose between geography and science as a class-subject. He may take *either*, but he cannot take *both*. As a rule he takes geography. It is to be hoped that in the future this restriction may be removed, and that a simple course of object-lessons on plants, animals, manufactures, &c., which would fulfil the requirements of science as a class-subject, will be given *in addition* to those lessons on geography which are really indispensable.

(*b*) The three years' course in a specific subject is too long, now that the child does not begin the study until it enters the Fifth Standard. Taking the case of the boys and girls presented for examination during 1883 in the Birmingham Board schools, we find in Standard V. 1864 children; in Standard VI. 482; in Standard VII. 85.

Tracing back the eighty-five Seventh Standard children, we find that they are the residue of 427 Sixth Standard children of 1882, and of 1223 who passed the Fifth Standard in 1881. It would probably be better to reduce each specific subject to a two years' course, and to allow Seventh Standard children to be examined in the work of the *two* previous years.

CHOICE OF SUBJECTS.—In considering what science

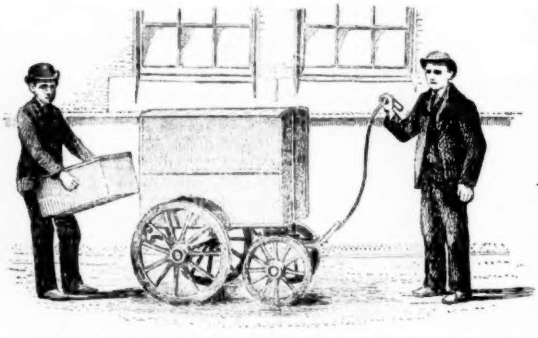


FIG. 1.—Hand-cart used for conveying apparatus from school to school.

subjects to select from those named in the Code, much will depend upon local conditions. Generally speaking, for boys' schools mechanics should be chosen, and for girls' domestic economy. As a second subject in town schools, either chemistry or magnetism and electricity may be recommended for boys, and animal physiology for girls. In country schools, principles of agriculture for boys, and botany for girls, will be found very suitable.

In the new Seventh Standard School, lately opened by the Birmingham School Board, there is an excellent workshop, fitted up with carpenters' benches, forge, lathe, &c., for forty boys. For this school I have drawn up a syllabus of a (proposed) new specific subject, entitled "Principles of Tools and Properties of Materials."

OBJECTIONS TO SCIENCE-TEACHING.—In time past three principal objections have been urged to the introduction of science-teaching into public elementary schools. These objections are:—

(1) *Want of Qualified Teachers.*—The ordinary teachers and pupil-teachers of our schools have not, as a rule, the sound knowledge of principles and practised powers of manipulation which are necessary in order to teach science with power and effect.

(2) *Want of Time.*—To *prepare* for a science-lesson, and to properly *clean and put away* the apparatus, requires more time than our closely-worked school-teachers are able to give. Some have also urged that "time" cannot be spared from the study of the "three R's," in which they consider incessant mechanical practice to be necessary.

(3) *Cost of Apparatus.*—To teach science practically—and it should be so taught to be of any value—a considerable sum must be spent in the purchase of apparatus. Thus the apparatus required for the three stages of mechanics costs about 75*l.*, and for domestic economy 65*l.*, and this is a considerable expenditure for a single school.

THE ITINERANT METHOD OF SCIENCE-TEACHING.—A method by which the principal objections urged against science-teaching in elementary schools may be overcome was suggested a few years ago by Col. Donnelly and Prof. Huxley, and it is not the least of the many services which these gentlemen have rendered to science and to education. This method has been carried out on a large scale, and with the most gratifying success by the School Boards of Birmingham and Liverpool, and the object of the present paper is to describe the manner in which the work is done in the former town.

The principal features of the itinerant method of science-teaching are as follows:—

(1) A science demonstrator is appointed, who should combine a practical knowledge of school-work and power to teach large classes with a thorough acquaintance with the branches of science which he is to teach.

(2) A "centre" is chosen in connection with some particular school, where a class-room may be set apart, or (better) a subsidiary building erected, where apparatus can be kept and the experiments prepared.

(3) A hand-cart must be provided (Fig. 1), into which the boxes containing the apparatus fit, and can so be conveyed from the science-centre to school after school by a strong youth. In this way one set of apparatus will serve for many schools. In each school department there must be a trestle-table, which should be placed in front of the class as the time for the science-lesson draws near. The hand-cart is brought to the school, the youth carries in the boxes, unpacks the apparatus, and places it upon the table. Then the science demonstrator walks in and gives the lesson. Afterwards the youth packs up the apparatus in the boxes, replaces them in the hand-cart, and marches off to the next school.

(4) A time-table is drawn up showing the exact time at which the science-lesson is given at each school, and its duration (forty-five minutes will be found suitable). A syllabus of each year's course of lessons must also be prepared (which should be distributed to the class-teachers and children), so that the subject may be gone through in a systematic way. As a rule it will be found possible for each science demonstrator to give four lessons per day, or twenty per week.

Each class should receive a lesson from the demonstrator at least once a fortnight. At each science-lesson the ordinary teacher of the class is present, and takes full notes of the matter given. During the intervening week the class-teacher *recapitulates* the science-lesson, giving such additional or new illustrations as he or she may be able to provide. The children then either write a general account of the lesson or answer three or four questions upon it, and the papers worked are submitted to the science demonstrator when he next visits the class.

It is plain that the itinerant system fairly meets the objections which have been urged against the introduction of science-teaching on the grounds of want of qualified teachers, want of time, and cost of apparatus. It also secures systematic and continuous teaching throughout the school year. The teaching is practical, and every fact or law is demonstrated experimentally. Wherever eight or ten schools are within a reasonable distance of each other, this plan may be carried into effect. Voluntary schools may combine with Board schools (as is done in Liverpool) to secure the services of a science demonstra-

tor, or small towns near to one another (as in Lancashire and Yorkshire, or in the Black Country), may unite for the same end.

APPLICATION OF THE ITINERANT SYSTEM OF SCIENCE-TEACHING IN BIRMINGHAM.—It was in June 1880 that I received my present appointment from the Birmingham School Board. Since that time the work in which I have been engaged has received the unanimous approval of the Board, but I ought especially to acknowledge the encouragement received from the Chairman—Mr. George Dixon—and from Dr. Crosskey, and the valuable advice given by the able and experienced Clerk to the Board, Mr. G. B. Davis.

Three assistants have been appointed, with a junior laboratory assistant, and two youths who work the two hand-carts which we now employ. The regular science staff thus includes seven individuals, whose salaries amount to 750*l*. per annum. In connection with the new Icknield Street School an admirable laboratory has been erected, at a cost (with fittings) of 1450*l*., including a lecture theatre to seat eighty, a chemical laboratory and store-room, and a demonstrator's room (Fig. 2). About 400*l*. has been expended in the purchase of apparatus.

There are now thirty schools under the Birmingham School Board, attended by nearly 40,000 children.

In each of the thirty boys' departments Mechanics is taken as a specific subject by every boy in the Fifth and higher Standards; six departments take magnetism and electricity as a second specific subject.

In each of the thirty girls' departments Domestic Economy is taken as a specific subject by every girl in the Fifth and higher Standards; three departments take animal physiology as a second specific subject.

At the request of the teachers a few Fourth Standard children of exceptional ability are allowed to attend the science-lessons, since it is found not merely to do them good mentally but to induce them to remain longer at school.

The total number of children now receiving instruction in science in the Birmingham Board schools is, in round numbers:—

Mechanics	2400 boys
Magnetism and Electricity ...	300 ,,
Domestic Economy	1800 girls
Animal Physiology	100 ,,

In the framing of the syllabuses a wide interpretation has been given to these subjects; thus under the head of domestic economy as much elementary chemistry and physiology are taught as will enable an intelligent girl to comprehend the familiar facts of home life.

As a rule two science-teachers and two youths go with each hand-cart, so that the lessons to boys and girls go on simultaneously in each school. By this plan each hand-cart can visit four schools (eight departments) daily, while with a single teacher only two schools (four departments) could be visited.

The same lesson is given to class after class throughout the week. It is previously very carefully prepared by the science-demonstrator, is written out in full by him, and the experiments are tried over and the apparatus packed on Saturday morning, so that everything is ready for the start on Monday morning.

In each science subject there is but *one stage* taught in each school. Children entering on the subject join in at the second or third stage, as the case may be, so that all the children in any one department form one class, working at the same stage of the same subject. This plan simplifies the work wonderfully, and it is found in practice that the science subjects taken may be as conveniently commenced at any one of the three stages into which each is divided in the Code as at any other. Each stage stands quite by itself, and each may be considered in turn as forming an introduction to the other two.

RESULTS OF THE SCIENCE-TEACHING IN BIRMINGHAM.—The visits of the science demonstrator have been welcomed both by the teachers and children of the Board schools. The teachers have earnestly co-operated in the work, and much of its success is due to their efforts. With the children, the science-lessons have proved extremely popular. There is invariably a good attendance on the day of the science-lesson. Among the boys the half-timers then muster strongly, often getting leave to come in for that lesson only, and sitting with bare arms and rolled-up aprons, just as they have run from their work. In the same way big girls, who cannot escape from tyrannical babies, beg leave to bring their charges into the class-room; and I know of many a case where "mother" has been persuaded to change her "washing-day" because it

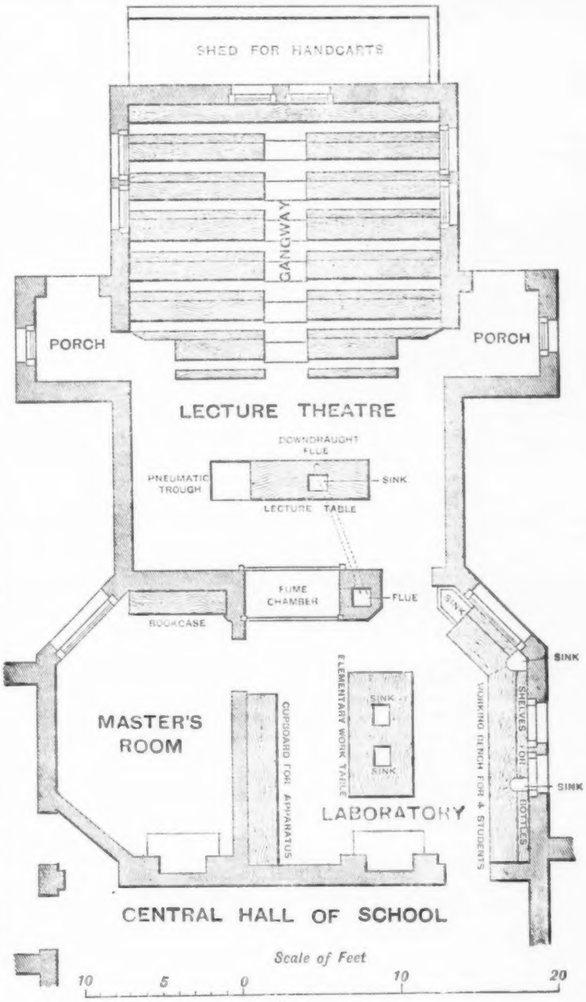


FIG. 2.

clashed with the day of the demonstrator's lesson in domestic economy. The teaching has evidently been carried home, for an irate landlord visited one school to "know what they meant by teaching children that his houses were not fit to live in!" the said houses being built "back to back," a practice the evils of which are pointed out in one of our domestic economy lessons. The large number of papers, essays, mechanical drawings, models of apparatus, &c., exhibited by the Birmingham School Board at the Health Exhibition will give some idea of the results of the work and of the eager manner in which it has been taken up by the children. So far from the science-lessons having interfered (by taking up time which would otherwise have been spent on the three R's) with the ordinary school work, the unanimous testimony of the teachers is that the increased intelligence of the children enables them to do their Standard work more easily. The idea has been very prevalent that by incessant mechanical practice excellence in the "three R's" can be secured; but the fact is that unless the intelligence be cultivated, no subject can be properly learnt. True education is culture of the mind, and mechanical acquirements have nothing in common with culture.

Applying to the matter the practical test of the Government examinations by Her Majesty's inspector, the results come out in a very satisfactory way.

Year	Number of passes in specific subjects	Percentage of passes in the three R's
1878	121	81·3
1879	424	82·0
1880 [1]	841	84·7
1881	1724	88·4
1882	3114	92·6
1883 [2]	3150	89·6

Another pleasing fact is the much larger number of children now found in the upper Standards. In 1879 (the year before the introduction of science-teaching) the percentage of children examined in Standards IV. to VII. was only 19·5; it is now 33·7.

The following extracts from the published reports of the Birmingham School Board prove that, in the estimation of those best able to judge, the teaching of science has proved a success.

1880.—"An important addition to the work of the Board schools has been the introduction of experimental lessons in elementary science. A science demonstrator has been appointed, and has now commenced work."

1881.—"In June 1881 the Board decided to appoint an assistant science demonstrator. The lessons in elementary science had proved so successful and attractive, that it was felt to be unfair that such advantages should be denied to some schools while they were afforded to others."

"These science-lessons are fully answering our expectations; the children are very attentive and much interested in the work; and, in addition to the useful knowledge they gain, their general intelligence is being developed."

1882.—"The success of the science-teaching has been strongly marked, both by the papers worked by the candidates for the science scholarships, and by the greater development of intelligence shown in regard to other subjects."

"As the teaching of science in Board schools has now become exceedingly popular, and many of the children have made considerable progress, six scholarships of 10*l.* each have been founded in connection with the Science and Art Department."

"Upwards of one thousand boys are now receiving admirable lessons in elementary science in the Board schools, and the result of this teaching is little less than marvellous."

1883.—"The teaching of elementary science in the Board schools has developed considerably during the year, the scholars taking great interest in it, and the results shown by the examinations being such as to prove that the knowledge imparted has been largely retained."

"Two great steps in advance have been made by the present Board. One is the establishment of science classes. The remarkable success which has attended these classes has been frequently alluded to, and is generally known."

Science Scholarships.—Twelve science scholarships of 10*l.* per annum have now been established in connection with the Science and Art Department. The boys who obtain these scholarships, together with an equal number selected as showing special aptitude for science, spend each Friday afternoon at the science laboratory in the study of analytical chemistry. All those hitherto examined have passed (and a large number in the first class) at the May examinations of the Department.

There are also two valuable science scholarships by which boys may pass from the Board schools to King Edward's Grammar School, and thence to the Mason Science College, their parents meanwhile receiving allowances of 15*l.* and 25*l.* per annum for their support. These scholarships are very keenly competed for, the usual number of boys examined being over 200. The examiner, Prof. Poynting, M.A., of Mason College, reports as follows:—

1882.—"Hardly any of the questions in my paper could have been answered without independent thought on the part of the candidates, and I had but very few answers showing a want of such thought. The boys showed that they had seen and understood the experiments which they described, that they had been taught to reason for themselves upon them, and that they were not merely using forms of words which they had learnt, without attaching physical ideas to them."

1883.—"The paper worked by the boy who stands highest on the list was an excellent one, and showed considerable power. The next five boys also deserve special mention as having done very good work. I think the general style of work sent in was very satisfactory. The average was not so high as last year, as the third stage of the subject was far more difficult, and the paper set was also much harder, but I think that quite as much ability was shown on the part of the candidates, and that the evidence of careful teaching was quite as strong."

Mr. Richard Tangye—the head of the great firm of Tangye and Co.—has taken a warm personal interest in the work, and his aid and countenance have been most valuable. He testifies strongly to the great improvement of his young "hands" since the introduction of the School Board system in Birmingham.

Summing up the matter, the results which we hope to obtain from this science-teaching, and which indeed have already manifested themselves, are:—

(1) The general quickening of the intellectual life of the school.

(2) The imparting of scientific knowledge and method to children which will be useful to them in after life, and which will cause many of them to continue their science-studies in evening classes.[1]

(3) The discovery of children of exceptional ability, and their support by means of scholarships.

(4) The instruction of the school-teachers in scientific principles, which they may apply to the general work of the school.

Evening Work in Science.—The work done among the teachers by means of evening science classes in connec-

[1] Science demonstrator appointed June 1880.

[2] Mundella Code introduced, by which Literature (in which 1435 passes were made in preceding year) was removed from list of specific subjects. The general requirements of this Code being higher, there was a slight drop in the percentage of passes for this year

[1] The last Report of the Birmingham and Midland Institute speaks of the influx of youths into the evening science classes—"the result doubtless of the science-teaching now carried on in the Board schools."

tion with the Science and Art Department has been of an important character. The Birmingham School Board employs about 800 teachers, and it now provides education, by means of training classes, for about 450 (the pupil-teachers and uncertificated assistants). The growth of the science work in this direction will appear from the following table:—

Year	Number of Certificates obtained	Number of First Class Certificates awarded	Gross Grant
1881	24	0	£18
1882	91	18	£108
1883	100	24	£124
1884	173	33	£197

It is very important to elementary school teachers to do well in science, since (by a regulation of the Education Department) those who have passed in science have a certain number of marks added to those which they obtain for other subjects at the Queen's Scholarship and Certificate Examinations, through which all these teachers have subsequently to pass.

Electricity and magnetism has been taught to the pupil-teachers, and physiography to the assistants.

When evening science lectures are given, however, no school-work can be done by the demonstrators in the afternoon of the same day, as the time is taken up with the preparation of the experiments, &c., for the evening lectures.

The Board possesses an excellent optical lantern presented by Messrs. R. and G. Tangye as a token of their appreciation of the science-teaching and with its assistance the science demonstrator gives popular evening science lectures in the various schools, taking subjects such as will be likely to awaken the interest and increase the intelligence of the children, as "Wild Animals in the Zoo," "The Star-lit Sky," "Two Days in London," "A Voyage to the Moon," &c. Occasionally, on fine evenings, the elder children are shown the moon, planets, double-stars, &c., through a three-inch achromatic telescope (refractor). These expositions tend to attract children to school, and to improve the regularity of the attendance.

COST OF THE SYSTEM.—The following rough balance-sheet for the year 1883-84 shows the very small cost at which the work of science-teaching is carried on in Birmingham:—

	£	s.	d.
Receipts.			
Half of Government Grant on specific subjects ...	160	0	0
Grant from Science and Art Department	150	0	0
	£310	0	0
Expenditure.			
Salaries	750	0	0
Interest on cost of buildings and apparatus ...	70	0	0
Renewal of apparatus and cost of materials ...	50	0	0
	£870	0	0
Net cost to the Board ... ... £560 per annum.			

As a penny rate yields 6000*l.*, it will be seen that the cost of this system, by which more than 4000 children, distributed over sixty school departments, receive regular and practical science-lessons, amounts to only one-tenth of a penny in the pound, or to 9*l.* 10*s.* per annum for each school department. It must be remembered also that the full benefit of the system has not yet been reaped, and that the grants will certainly continue to increase. Credit has only been taken for one-half of the grant for the specific subjects.

TEXT-BOOKS.—Failing to meet with works exactly suitable for the wants of the children, the science-lessons in mechanics and in domestic economy have been written out in full, and are now published by Messrs. T. Nelson and Sons. Similar works on magnetism and electricity and on chemistry are nearly ready for issue. Each work consists of three small volumes corresponding with the three years' course prescribed by the Code. These books have already been adopted by the School Board for London, the Irish Intermediate Education Board, and other important educational bodies.

SCHOOL MUSEUMS.—For use in object-lessons, and as a constant source of pleasure and instruction, a small collection of typical objects stored in a glass-fronted cupboard ought to be placed in every school. Such cupboards are now being supplied to the Birmingham Board schools, and it has naturally fallen to the lot of the science demonstrator and his staff to assist in the mounting, naming, and classification of the objects with which the cupboards are, at little or no expense to the Board, to be filled.

CONCLUSION.—Since the commencement of this system of practical instruction in science in Birmingham, many eminent men have visited the schools to see it in operation, and they have been unanimous in their approval. In the "Instructions to Inspectors" issued by the Education Department, the system receives official sanction and commendation:—"You will often find that these (specific) subjects are most thoroughly taught when a special teacher is engaged by a group of schools to give instruction in such subjects once or twice a week, his teaching being supplemented in the intervals by the teachers of the school."

The Commissioners for Technical Education visited the Icknield Street Centre a few months ago, heard science-lessons given, and examined fully into the work. In their valuable Report, recently issued, they say:—"We could hardly overstate our appreciation of the value of the plan of giving instruction in natural science by special teachers as carried out in the Board schools of Liverpool and Birmingham, where the employment of a well-qualified science demonstrator insures the sound character of the instruction, whilst the repetition of the lesson by the schoolmaster enables him to improve himself in the methods of science-teaching."

Within the present year the work has been crowned by the opening of a Technical School for Seventh Standard boys, situated in the centre of the town, and fitted with an admirable laboratory (for forty boys), lecture-theatre, workshop (for forty, with three lathes), room for drawing, class-rooms for the ordinary subjects, and a capital dining-hall, &c. The building has been adapted, fitted (at a cost exceeding 2000*l.*), and presented rent-free to the Board by Mr. George Dixon. This school will constitute the last link of the chain of elementary education supported by the town, and who can doubt that in it will be laid the foundation of many a good work, both for the individual and the community.

NOTES

MR. J. J. THOMSON has been elected to fill the post of Cavendish Professor of Experimental Physics in the University of Cambridge in succession to Lord Rayleigh. A numerously signed requisition to Sir Wm. Thomson to become a candidate was declined.

CAMBRIDGE was *en fête* on Monday. Peterhouse, the oldest collegiate institution in the University, was celebrating the six-hundredth anniversary of its foundation. It was stated at the dinner that one-third of the present Fellows were Fellows of the Royal Society.

IT is announced that the International Sanitary Conference, which Signor Mancini proposed some time ago, will meet at Rome in February or March. Later on another Conference, also suggested by Signor Mancini, will meet to consider the possibility of some agreement for the mutual execution by the Signatory Powers of legal judgments.

THE monthly weather review of the Signal Service, prepared, as announced for the first time in the August number of *Science*, by Second Lieut. W. A. Glassford, has come to be a quarto of twenty-eight pages, with five charts. This is a good growth from the four small pages and three charts of the first issue, eleven years ago. Then, the headings were storms, anti-cyclonic areas, temperature, precipitation, peculiar phenomena and facts, rivers, and cautionary signals: now, all these subjects are treated in much greater detail; and among the many additional topics there may be mentioned atmospheric pressure and its range (illustrated by a new style of chart), Atlantic storms and ice, range of temperature, frosts (illustrated by a chart for August 9 and 25), winds, local storms, tornadoes and thunderstorms, sunsets, drought, two and a half pages on the earthquake of August 10, meteors, and notes of State weather services for Alabama, Nebraska, Tennessee, Missouri, Louisiana, Ohio, and Georgia. The storm-tracks for the month are remarkably regular, and, with insignificant exceptions, all lie north of the Great Lakes and St. Lawrence: no tropical cyclones were felt along the sea-coast. Nine tornadoes are reported, and many violent thunderstorms. Some of the results of the special studies of the latter, undertaken by Mr. H. A. Hazen during the past season, take form in a brief summary, from which it appears that the mean distance and direction of the 900 thunderstorms reported in August, from the centre of the broad cyclonic storms in which they occurred, was 515 miles, a little west of south. A full account of these studies will be of much value and interest. Most of the observations on meteors are of small value, and, at best, they have but an etymological connection with a weather-review.

THE completion of the Lick Observatory is stated by *Science* now to depend upon the successful making of the disk of glass for the objective of the large telescope. The main dome cannot be made till the focal length of the large equatorial has been determined.

A MEMBER of the Institute of France has brought forward a scheme for the foundation of a number of annuities, of the value of 80*l.*, 160*l.*, and 240*l.*, to aid scientific men in the prosecution of experimental work, offering to subscribe 200*l.* towards the realisation of the scheme out of his own pocket. If the Government, who will soon have to decide on the application of Giffard's legacy of over 200,000*l.*, thought fit to patronise this scheme, they have the means of giving it practical embodiment on an extensive scale.

IN commemoration of the services to astronomy rendered by the French observers of the transit of Venus in 1874, the French Government have placed in the National Library of Paris a large monumental vase, designed and manufactured at Sèvres, bearing the following inscription: "La République Française à MM. Janssen, Bouquet de la Grye, André, Fleuriel, Hérault, Mouchez: Passage de Venus sur le Soleil en MDCCCLXXIV. Hommage du Gouvernement Français au Science." This vase, about 2 m. high by 1 m. broad, at present standing at the entrance of the Reading Room of the Library, will remain there for public inspection for some time, after which it will be removed to the Gallerie Mazarine, which contains a collection of rare manuscripts and other treasures.

A NUMBER of scientific men in Paris having founded a club called "La Science," for the purpose of dining together at stated times, recently entertained M. Chevreul at a banquet. The toast of the occasion was proposed by M. Jamin, the new Perpetual Secretary of the Academy of Sciences. M. Pasteur has been nominated Chairman of the next banquet. A similar club was instituted six years ago under the name of "Banquet de la Presse scientifique."

IN his discourse on re-election to the Presidency of the Biological Society of Paris, M. Paul Bert stated that he had intended endeavouring to summarise the work of the Society during the preceding five years that he had held the office. But he found the task so difficult on account of the mass of facts presented by the publications of the Society, and the brevity of the papers, that he decided to abandon the idea. He promised, however, in future, at the commencement of the annual sessions, to sum up rapidly the progress realised during the preceding one. The scientific world will doubtless look forward with interest to the annual statements of the advance of biological research thus promised.

THE Museum of the International Association at Brussels has just received a large collection of birds of all kinds, sent from Karema by Lieut. Storms; and also a collection made by Mr. Stanley during his last visit to the Upper Congo, consisting of utensils, furniture, musical instruments, arms, &c.

THE laying of the foundation-stone of the new Sorbonne buildings will take place in a few days, the houses which covered the site intended for the new edifice having been all pulled down and the ground around the old Sorbonne to the extent of several acres having been levelled. The new buildings are to be pushed on rapidly, and the plans connected with the undertaking contemplate giving quite a new aspect to this part of the Quartier Latin. The enlargement of the Sorbonne was projected by Napoleon III. some years before 1870, and he had so far made a beginning with the work as to pull down several houses, and with all due state lay the first stone towards the additional structures in contemplation. The "first of the first stones" so laid down has been removed, though there is a rumour current that after search this first stone has not been found, and people are at a loss to know what has become of it. At all events the laying of the second of the first stones of the new Sorbonne will shortly be celebrated with becoming ceremony.

THE International Society of Electricians has decided to hold an exhibition in January next, on the occasion of the first general meeting. The exhibition, which will last several days, is to be held in the rooms of the Observatory of Paris, which have been lent for the purpose by the director.

ACCORDING to the *Oxford Magazine* there have been several interesting additions lately to the collection of casts in the University Museum. By the side of the skull of a Dinotherium now stands the skull of a Mastodon. Casts of the complete skeleton of Halitherium, the curious Miocene Sirenian which possesses distinct though small hind limbs, and of the hind and fore feet of the gigantic *Iguanodon Bernissartensis*, the original of which is one of the chief features of the Natural History Museum at Brussels, have also been added.

AN exhibition of the arts, industries, and natural productions of the Malay Archipelago was opened under the patronage of the Government of the Dutch East Indies at Batavia last month. The productions of Penang, Singapore, North Borneo, and Sarawak are largely represented.

PROF. MELL, director of the Alabama Weather Service, announces that through the liberality of the chief signal officer and of several railways; daily weather signals predicting changes of weather and temperature, will in future be displayed at upwards of 100 telegraph stations in the State of Alabama. The predictions will be received by the director at an early hour every morning from the Signal Office at Washington, and then promptly distributed along the railways. On paying about six dollars, the cost of the signal flags, any town or telegraph station will receive free telegraphic warning of the daily weather changes. Only about five minutes are required to set the flags. A similar

extension of weather signals has been for some time in operation in Ohio and in a portion of Pennsylvania.

THE last Consular Report from China, published as a Parliamentary Blue-Book (China 6A Trade Reports), contains the appendixes to the annual report of the English Consul at Ichang. They deal with the animal, fossil, mineral, and vegetable products of the Ichang district. A considerable part of the *flora* appears to be employed only for medicinal purposes. The extracts from Mr. Gardner's diary of his travels through the province are sometimes extremely interesting; his account of a visit to the fossil quarries is especially so. Three kinds of fossils found in the district are staples of trade, the pagoda stones *Orthoceras*), kosmos stones (*Ammonites*), and the "stone swallows." The first is found in the slate, and is cut, and either framed as a picture, or made into ornamental furniture. The *Ammonites* receive the name of "kosmos stones" from their resemblance when polished to the Chinese symbol for kosmos. The so-called stone swallows are ground down, and, like much else in that region, used as medicine. These are fossil bivalves, and the name is given to them because the natives believe that they fly about underground in the same way that the swallow flies in the air. The fossil cutters appear to be a separate guild, and mostly converts to Christianity. The tools are merely a saw and a chisel. They prod about the slate until they find an *Orthoceras*, which they think will be perfect; they then cut out a slab, which they saw into two or three thin planks, so that the fossil looks like a white picture of a pagoda on a black ground. These various fossils are close together in a region at least thirty miles long, and Mr. Gardner thinks that there is hardly a cubic foot of the limey slate which does not contain a fossil or the fragment of one.

THE most recent link in the long chain of telegraph lines which is spreading with such rapidity over China is the land line from Shanghai to Canton. A line from Pekin to Tientsin was opened a few months ago, and the capital of China was connected directly with London. Now the capital of Southern China is joined with the metropolis in the north; and as Canton was put in communication by telegraph with the frontier of Tonquin at the outbreak of the present political troubles in the latter district, the telegraph now stretches in an unbroken line from Pekin in the north to the most southern boundary of the Chinese Empire, and a message either from London or Pekin might reach the head-quarters of the Chinese forces on the Tonquin frontier in a few hours. Four years ago the only telegraph line in China was one about six miles in length, stretching from Shanghai to the sea, and erected to inform the mercantile community of the arrival of vessels off the mouth of the river. The next important line constructed by the Chinese Government will probably be one uniting Pekin with the great northern lines across Siberia at Kiachta. This will have to cross the whole of Mongolia, and will give the capital of China a third alternative telegraph route to Europe, a matter to which some political importance is believed to be attached in China. As already pointed out in NATURE, this extraordinary development is due solely to political considerations.

A COMMISSION appointed by the French Government to consider the best method of developing the mineral wealth of Annam and Tonquin has just issued its report. It lays down a programme for a mining mission, which it has been decided to send out there, and suggests the appointment of two separate missions. The duty of the first of these would be to ascertain whether the metalliferous deposits stated by Annamite documents to exist in two north-western provinces of Tonquin do actually exist there, and how far it would be possible to work them profitably. The second should investigate the copper deposits of the delta, and subsequently extend its labours into Annam. A draft mining law for these regions has also been proposed. Its special provisions are those relating to the mutual rights of the owners of the soil and those who have been granted concessions to work the mines; to administrative intervention (which it is recommended should be as rare as possible) with private mine owners. The broad policy laid down by the Commission is very liberal, not only to the natives, whose rights or alleged rights are to be scrupulously respected, but also to other nations, whose subjects are, for mining purposes, to be placed on the same footing as Frenchmen. Work, it is said, can take place at once on the coal-measures known to exist on the coast of Tonquin, as well as in the adjacent islands.

THE several correspondents of *La Lumière Electrique*, who have been sent to report on the progress of electricity in America, have returned to Paris, and are preparing their reports, which will be published next year.

THE site for the Centennial French Exhibition has been selected. It is to be held on the Champ de Mars, which belongs to the War Office, but will be given up to the city of Paris. A part of the Champ de Mars will be sold for building purposes. The Central Palace of the Exhibition will be made permanent and used for yearly exhibitions like those held in London at South Kensington.

PROF. T. C. MENDENHALL, *Science* states, has been appointed Chief Electrician of the U.S. Signal Bureau.

THE additions to the Zoological Society's Gardens during the past week include a Silvery Gibbon (*Hylobates leuciscus* ♀) from Java, presented by Mr. C. H. A. Hervey; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mrs. J. N. L. Boljahn; a Common Roe (*Capreolus capræa*), British, presented by Mr. C. Hambro; a Common Rhea (*Rhea americana* ♂) from South America, presented by Lady Brassey, F.Z.S.; a Tawny Owl (*Syrnium aluco*), European, presented by Mr. W. P. Clark; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. R. O. S. Ogilby; a Greater Black-backed Gull (*Larus marinus*), British, presented by Mr. T. E. Gunn; a Herring Gull (*Larus argentatus*), a Common Gull (*Larus canus*), three Greater Black-backed Gulls (*Larus marinus*), three Black-headed Gulls (*Larus ridibundus*), British, presented by Mr. W. H. Fielden, C.M.Z.S.; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Brush-tailed Kangaroo (*Petrogale penicillata* ♀) from New South Wales, a Hairy-fronted Muntjac (*Cervulus crinifrons* ♂), two Michie's Tufted Deer (*Elaphodus michianus* ♂ ♀) from China, a Tawny Owl (*Syrnium aluco*), European, a Hobby (*Falco subbuteo*), British, deposited; two Common Guillemots (*Lomvia troile*), a Razorbill (*Alca torda*), British, purchased.

OUR ASTRONOMICAL COLUMN

OCCULTATIONS OF ALDEBARAN.—The next series of occultations of Aldebaran visible at Greenwich commences on February 22, 1885, and terminates on October 6, 1887. The dates and mean times of immersion and emersion are as follow:—

				Immersion h. m.		Emersion h. m.
1885	February	22	...	5 17	...	5 50
	March	21	...	11 43	...	below the horizon
	November	22	...	9 48	...	10 57
1886	January	16	..	7 48	...	8 49
	April	8	...	5 8	...	5 54
	November	12	...	18 27	...	19 16
1887	January	6	...	12 17	...	13 15
	March	2	...	5 47	...	6 4
	October	6	...	15 20	...	16 2

There are therefore eight occultations in this series in which both immersion and emersion are visible, and one in which only the immersion occurs while the star is above the horizon at Greenwich. In the last series, which commenced September 28, 1866, and ended on August 2, 1869, ten occultations were wholly visible.

Occultations of Aldebaran are on record as far back as the year A.D. 491; it is stated in the Chinese Annals that the star was occulted at Nankin on March 29. Apparently the first occultation observed in Europe was found by Bullialdus in a Greek manuscript, which thus describes it:—"Anno 225 Diocletiani, Phamenoth 15 in 16, vidi Lunam sequentem claram Hyadum post accensas lucernas, digiti unius ad summam semisse. Videbatur autem occultasse ipsam. Stella quippe apposita erat parti, per quam bisecatur limbus Lunæ illuminatus." Bullialdus makes the date A.D. 509, March 11, and an approximate calculation shows that he is correct. New moon fell about 7h. G.M.T. on March 6.

ENCKE'S COMET.—This comet at its present return will be observable in these latitudes in the early evening hours before perihelion. The following ephemeris is for 6h. G.M.T.:—

1885	R.A. h.	m.	s.	Decl. °	′	Log. distance from Earth	Sun
Jan. 1	22	55	26	+3	57·8	0·1526	0·1309
2	22	56	18	4	0·5		
3	22	57	12	4	3·4		
4	22	58	7	4	6·5		
5	22	59	3	4	9·8	0·1500	0·1120
6	23	0	1	4	13·3		
7	23	1	0	4	16·9		
8	23	2	0	4	20·7		
9	23	3	2	4	24·7	0·1462	0·0917
10	23	4	5	4	28·9		
11	23	5	10	4	33·2		
12	23	6	17	4	37·7		
13	23	7	25	4	42·4	0·1410	0·0699
14	23	8	35	4	47·2		
15	23	9	46	4	52·2		
16	23	10	58	4	57·3		
17	23	12	12	5	2·6	0·1344	0·0463
18	23	13	27	5	8·0		
19	23	14	44	5	13·5		
20	23	16	2	5	19·1		
21	23	17	20	5	24·8	0·1261	0·0206
22	23	18	40	5	30·7		
23	23	20	1	5	36·6		
24	23	21	24	5	42·6		
25	23	22	47	5	48·7	0·1158	9·9926
26	23	24	11	5	54·8		
27	23	25	37	6	1·0		
28	23	27	4	6	7·2		
29	23	28	31	6	13·5	0·1033	9·9619
30	23	30	0	6	19·7		
31	23	31	29	+6	25·0		

The intensity of light expressed in the usual manner is 0·27 on January 1, and 0·51 on the last date of the ephemeris.

GEOGRAPHICAL NOTES

AN interesting project was laid before the Associated Swiss Societies of Geography at their meeting at Berne last month, by M. Müllhaupt. He suggested the formation of an international geographical bureau for the following purposes:—(1) To carry out the resolutions arrived at by the International Geographical Congresses. (2) To make exchanges every month, or oftener if need be, between the eighty odd geographical societies; in place of each society sending its own publications in eighty different directions, it would only have to send them all at once to the bureau, which would do so. This, he claims, would save both time and money. (3) To publish, in the four or five principal languages, a summary of the contents of the publications of the various geographical societies; instead of each society being forced to do this for itself, a single examination would suffice to put them all *au courant* with what has been done all over the globe. There would in this way be the further advantage of knowing what was published by societies like the Geographical Society of Japan, the publications of which are in a language not generally known in Europe. M. Müllhaupt thought that the idea was not a difficult one to be carried out; the expenses would be shared by the numerous societies interested. These contain approximately 38,000 active members, and doubtless the countries having an interest in the progress of the geographical sciences would take part in a central organisation of the nature here suggested.

THE last number (Band xi. No. 8) of the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* contains two papers on West Africa: one accompanied by an excellent map, by Herr Flegel, of his recent journey along the Niger to Adamawa; the other, by Herr Reichenow, on the Cameroons, and the German colony there. Dr. Lopez writes on the Argentine States, and the importance of the German element in the foreign population there.

THE investigation of the subterranean course of the Reka River has been actively pursued for some time past by the Coast Section of the German and Austrian Alpine Society. The Reka is that mysterious river which, coming from the Schneeberg in Carniola, loses itself in the caves of the Karst, and after a subterranean course of more than thirty kilometres, breaks out of the ground near San Giovanni di Duino, is then called the Timavo, and eventually flows into the Bay of Monfalcone. Already, on March 30 last, a part of this subterranean course was investigated by a party starting from the village of St. Canzian, where a celebrated cave is situated, into which the Reka falls with thundering noise when the water is high. In September a second exploration was made. The first subterranean cave is called the Rudolfsdome; it was from here the explorers started in two boats. First, they passed a canal about sixty metres in length, very narrow, and bounded by rocky walls one hundred metres in height; then a large cave was reached, where the party landed and fastened the boats, as waterfalls and rapids prevented further progress in boats. The underground journey was now continued on the rocky banks, the river being crossed several times on ladders. Thus six waterfalls were passed, and a seventh was reached. Altogether the explorers penetrated to a distance of between two and three hundred metres underground.

BULLETIN No. 5 of the U.S. Geological Survey is, *Science* remarks, a dictionary of altitudes in the United States, compiled by Henry Gannett, chief geographer of the Survey. It is essentially an extension of the "Lists of Elevations," prepared by the same author for Hayden's Survey; but, with the present broader organisation of the Geological Survey, the lists now appropriately include the whole country, while the earlier editions were concerned chiefly with the region west of the Mississippi. A list of authorities fills eight pages, and railroad abbreviations occupy eight more; then the States and stations follow alphabetically, the number of altitudes given being about 18,000. It is stated that the collection of railroad profiles for Pennsylvania is exceptionally complete and admirably adjusted, making the portion of the dictionary referring to that State by far the fullest and most satisfactory. By an unfortunate oversight, it is not stated whether the base level is high, mean, or low tide.

AT the recent meeting of the Ethnological Section of the Imperial Russian Geographical Society a paper was read describing Adrianow's journey through the Altai Mountains in 1881. The traveller was only able to take four companions, on account of the meagre funds at his disposal; nevertheless he was able to obtain excellent results, and to penetrate hitherto unknown regions. Although the southern slopes of the Altai Range have already been the object of investigation of various students, such as Pallas, Ledebur, Humboldt, and others, the eastern part of the region, the vast districts between the River Tom and the Government of Yenisei, have been almost a *terra incognita*. Adrianow's expedition started from the town of Kustnetsk, crossed the River Lebed, examined Lake Teletsk, touched Chulshman, Jan, and Agalan, crossed the Shapshal Pass, advanced to the River Kemchik, and sought for and found the sources of the Yenisei. They travelled through the region through which the river flows to the town of Yeniseisk, where the expedition came to an end. Throughout the journey Russians were found only around the sources of the Yenisei and on the River Usg. The population of the Altais is composed of sectaries who emigrated thither during the last century; their existence was wholly unknown until 1868, when they were by chance discovered by a Russian officer who was surveying there. Adrianow met similar colonies at Tobut on Koko-nor. These were founded in 1800. The colonists are described as savage and predatory. Besides these the traveller visited the so-called Black Tartars, on the rivers Koudoma and Luida—a tribe which has only once before been visited and described. They are regarded as descendants of the great Finnish and Turanian tribes, but hardly anything in an anthropological sense is known about them. The travellers also brought back a considerable number of pictures of monuments and works in stone, which exist among the Sajans and in Mongolia. Those of monuments to the dead are very interesting; some of them are merely

conical heaps of stones, while others are laid quite flat and are surrounded by a circle of larger stones; a third kind exhibit a primitive art of stone-cutting, the stones bearing a distant resemblance to the human body. Frequently around the graves the bones of horses which had been brought as sacrificial offerings, were found, as were also certain Runic inscriptions.

M. ADRIANOW, in his journey through the Altais, notices the existence in these regions of immigrant communities which have been forgotten and which have been re-discovered by chance. It is also reported from St. Petersburg that a similar discovery has been made elsewhere in Siberia. In the course of a prolonged inspection of his province, the Governor of Irkutsk (Governor-General of Eastern Siberia?) came across a town called Ilim, with 500 inhabitants, 150 houses, and four ancient churches, with remarkable relics of Cossack times. It is stil under the republican rule of a *vetche*, or public assembly, convoked by a bell, as in old Novgorod the Great, although the new municipal institutions were supposed to have been applied to that part of the Empire ten years ago. Not one of the inhabitants can read or write.

AN important geographical work on Austro-Hungary is now being produced in parts by Mr. Alfred Hölder, the publisher, of Vienna. The author, Prof. Umlauft, gives in alphabetical order the names of the various States and peoples of the Austro-Hungarian empire, as well as those of the more important districts, mountains, rivers, and towns, with their meanings. He does not, however, confine himself simply to present names, but also gives the forms employed formerly and the various changes which the name has undergone from the earliest times down to the present day. The work is thus historical and philological. The total number of names treated will be between six and seven thousand. The first part, which has appeared, contains 1041 names, from Aa to Donau. Geographical names, it is said, not only have their history, they are themselves pieces of history. The distinction between the German and Slav names of places is characteristic. The great majority of the German village names are connected with those of persons, probably the founders or original owners, more rarely with that of the patron saint. Thus Simmering comes from Simoning, Hütteldorf from Utendorf, Hadersdorf from Hadrichsdorf, Kalksburg from Chadalhohisperg (*i.e.* mountain of one Chadalhoh), Domsdorf from Dominiksdorf. The change wrought in course of time in some names has been very great, and renders their explanation difficult. The Slav names, on the other hand, are mostly taken from the position of the place or some peculiarity in the neighbourhood. They also manifest great stability of form, and it is only in their Germanising that they have materially altered. Thus the Czech Brloh becomes in German Bierloch, Ratibor Rothwurst, and Radoina Rothweim. The Czech Lhota, which means simply a settlement which is free from taxation, assumes in German such various forms as Oehlhütten, Elhotten, Ellgoth, Wellhotten, Welhütten, Wellhütten, Mehlhüttel, Malten, and others. Even real German names have undergone the same eccentric change, and names which in their original form are quite clear in their meaning have by a slight change become incomprehensible; thus Donnersmark is really Donnerstagmarkt, or Thursday Market. It may be remembered that some articles in the *Times* during the autumn, followed by a long correspondence, did much interesting and valuable work of this kind for English place-names, though of course in a less regular and systematic form.

MR. IM THURN's Roraima expedition left Kalacoon on October 16 with three boats and crews of seventeen Pomeroon and two Mazarooni Indians, and on the following day they ascended the first falls of the Essequibo. Simultaneously with their departure from Kalacoon, an expedition for Roraima, under the charge of a commercial botanist named Siedel, left Bartica for Roraima *viâ* Mazarooni. The two parties will probably meet on the mountain.

M. AYMONIER, a Saigon official, has recently returned from a journey of exploration in Indo-China. He left Saigon at the end of September last year to explore Southern Laos, and made a collection of the ancient Cambodian inscriptions. Having explored the intervening country, he reached Bangkok at the end of June last, and here he remained for some time to complete his studies on the Siamese kingdom. The result of his travels will shortly be published in the "Excursions et Reconnaissances," and he will afterwards proceed on another journey of exploration in Annam.

ROOTS[1]

IN treating of the roots of plants this evening, I may request you to dismiss from your minds any expectations or apprehensions of marvellous descriptions of tropical or rare roots on the one hand, or of a list of the peculiarities of various kinds of roots or so-called roots on the other, though it is not improbable that some of the facts will be, in part at least, new to some of you, as they certainly are to many people. I do not propose even to put any new discoveries before you. It has seemed much more to the purpose to show, as well as time will permit, that a vast amount of interesting and important information can be derived from a proper and systematic study of the roots of a common plant—information, moreover, which is important alike to the scientific botanist and to the practical agriculturist, two people who find they have more and more in common each day they come to know one another better. As the diagrams must in part have told you already, I propose that we meet on ground familiar, to a certain extent, to every one; and the sequel will show, I hope, that we have in no way acted unwisely in taking each other into confidence on the subject of an ordinary root, such as is well known to all of us. So much is this the case, that our study may be confined for the most part to the root of the common broad bean and a few other plants of our gardens.

[The lecturer then shortly described the germination of the common bean, maize, and a few other plants, and illustrated by diagrams the mode in which the first or primary root of the bean seedling emerges below, as the young seedling shoot (or "plumule") prepares to force its way upwards to the light and air. Next followed a short consideration of what this root may be said to be.] Anticipating matters to a certain extent, it may be shortly described as an organ for fixing the rest of the plant to the substratum, or soil, from which it absorbs certain food-materials. By confining our attention to this typical and well-known form of root, we may avoid any complexities resulting from the consideration of the more extraordinary cases occurring among the lower plants, or among curious aërial epiphytes, parasitic or otherwise, and other abnormal forms—forms which would demand several lectures by themselves.

The roots we have to consider, then, are organs for anchoring the rest of the plant firmly into the soil, and for absorbing certain matter dissolved in water from that soil. Obviously, we may do well to see, first, how the root gets into the soil; and secondly, how it accomplishes its objects when there.

When the young root first peeps forth from between the coats of the seed, it is seen to have its tip directed downwards towards the centre of the earth. Now this is not an accident; for if the seed be turned over, so that the apex of the root is made to turn upwards, its tip soon bends over, and again becomes directed downwards. [Mr. Ward then proceeded to explain, as shortly as could be done without detailed experimental evidence, that this persistent turning earthwards of the young root is due to a peculiar property, almost of the nature of a sensitiveness or perception to the influence of gravitation, and is not due merely to the weight of the organ.]

Next, evidence has been obtained to show that the tip of the root has a slightly rocking or swinging movement, which is more or less of the nature of the movements so well known in the case of the stems of twining plants; the tip of the root, in fact, not only moves earthwards, but tends to describe a very steep spiral as it does so. These successive very slight noddings to all sides of the tip as it proceeds in a line directed towards the centre of the earth are extremely slight, it must be borne in mind, but they may aid the point of the root to wriggle its way between the particles of earth in a loose soil, or to run down any crevice or hole it meets with.

Thirdly, in addition to its determined tendency to descend, though in a very slightly spiral course, the tip of such a root as we are describing has been found to be peculiarly sensitive to the contact of solid bodies. This extremely curious phenomenon could only be fully described by references to experiments and matters which we have scant time for. It must suffice, therefore, to state that there is evidence to show that the *extreme tip* of the root, on coming in contact with a hard resistant body, is caused to turn aside *from* that body, and if it comes simultaneously into contact with two bodies, one of which is harder than the other, it is caused to bend away from the harder of the

[1] Abstract of a lecture delivered before the Manchester Horticultural Society, in the old Town Hall, Manchester, on November 6, by H. Marshall Ward, M.A., Fellow of Christ's College, Cambridge, and Assistant Lecturer in Botany at the Owens College.

two. This property is all the more curious because, at a portion of the root a very short distance behind the tip, contact with a solid body causes that part of the root to curve *over* the touching body, much in the way that my finger is now curved over this wooden pointer. As already stated, time will not admit of our examining these very remarkable matters more closely—they form subjects for lectures in themselves.

But we have not yet finished our survey of what these sensitive tips of the roots are capable of. Experiments show that they turn towards a wet surface or atmosphere—a fact of great importance, and one which no doubt lies at the base of the explanation of the choking up of drain-pipes, &c., by the roots of neighbouring trees. Further, the apex of the root of such a plant as the bean we are considering avoids the light—avoids it as energetically as the leaves and green parts turn towards it. The two facts thus tersely put, viz. that the tip of the root tends towards a damp spot and avoids an illuminated one, are of course also in agreement with the rest of the behaviour of our germinating bean, and hence the root descends into the damp, moist, granular soil.

It is now time to see what sort of structure this wonderful root-tip possesses, and to inquire whence comes the impulse which drives it forwards into the soil—for it will be seen that while the forces producing the various curvatures which have been referred to tend to guide the apex of the root downwards between the particles of soil, towards the darker, moister, deeper parts, they cannot be expected to drive it into the soil.

In the first place, the tip is a firm, conical, smooth body, covered with a slippery, loose root-cap, as seen in the diagrams. Now, it cannot be too carefully borne in mind that the true tip of the root, beneath the covering cap, is resistant and somewhat elastic; it consists of multitudes of minute tightly-packed cells, each densely filled with protoplasmic substance containing very little water, and of a consistency resembling in some degree that of a well-made, hard-set jelly. Perhaps, indeed, a better idea of it may be gained if the conical tip of the root is compared to a firm, resistant jelly, cut up by delicate partitions into multitudes of minute blocks, which, however, are not separated from one another at all. In any case, it is clear that such a cone, if steadily and slowly driven by a persistent force from behind, is admirably adapted for penetrating between the particles of soil, especially if we bear in mind the following facts: (1) the cone is protected by a slippery cap of loose cells, which prevents the abrasions of the particles of soil from injuring the cells beneath; (2) the driving force is steady and continuous, and directed vertically, *i.e.* along the axis of the cone; (3) the tip oscillates slightly from side to side, and is thus probably (though not to any very great extent) insinuated between the earthy particles, no doubt being aided to a certain extent by other properties to which allusion has been made. It is of course obvious that the last thing we should expect of such a cone is that it could take up quantities of water from the soil: its structure is clearly in no way adapted for such a purpose, if only from the fact that there would be nowhere for the water to effect an entrance.

And now comes the question, What is this steady, continuous driving force from behind? Well, it is due to the simultaneous elongation of the hundreds of thousands of little cells situated a short distance behind the more rigid cone we have just examined. No doubt it seems a hard fact to grasp—that the absorption of water, and the intercalation of minute particles of substance in the interior of the cells shown in this diagram should be capable of steadily driving the apex of the root into the soil; but it is a fact nevertheless. Perhaps you will apprehend the matter more clearly if I offer you a well-known illustration which, it is true, does not exactly cover all the facts, but which will, at any rate, aid you in overcoming some initial difficulties. You are well aware that a wedge of wood driven firmly into a crack in a rock and then moistened, swells, and that it may swell so powerfully as to fracture the rock; very well, the elongation of the cells behind, which steadily drives the firm cone of the root forwards, is to a great extent due to the absorption of water, which causes each cell to grow longer. I say to a great extent, because, while the water is, on the one hand, absorbed in a slightly different way and enlarges the volume of each cell to a much greater extent, there are, on the other hand, forces at work which cause new particles of substance to be added to those originally composing the cells, and so fix the cells, as it were, in their condition of greater elongation, strengthening them at the same time. But this is not all. Besides growing longer, and thus driving the apex steadily forwards, the cells behind increase in diameter, and so push aside the particles of the soil with a force which would astonish you if I entered into figures; this, however, can only be adverted to here, since we must now pass to the explanation of one or two other points.

It is clear that, great as is the driving force supplied by so many elongating cells—and, of course, it is upon the simultaneous action of countless thousands of cells that the driving power depends—it would soon cease to be of much use unless a holdfast were insured at some point behind. This brings me to the consideration of an extremely important matter, and one on which I hope to make you quite clear. At first, while the root is still very young (as in this diagram), the weight of the seed above, with that of any soil covering it, seems to suffice to afford the necessary points of application; and this will doubtless be supplemented immediately afterwards by the increase in diameter of the upper part of the root.

When the root has attained some little length, however, a striking change takes place in its behaviour to the surrounding soil. First, let me call your attention to the following points, as illustrated by these diagrams. When the young primary root has attained a length of about four to six or eight inches—depending on circumstances which we need not occupy time in examining—the older portion nearest the seed has ceased to grow in length, and its surface is becoming clothed with a dense covering of very delicate hairs, which will be referred to in future as the "root-hairs." Each root-hair is an extremely slender sac—a sort of long tubular bladder, in fact—which possesses in virtue of its peculiar organisation an extraordinary aptitude for taking up water, and for attaching itself to the particles of soil with which it comes in contact. These facts are well illustrated by reference to these diagrams, to which I wish your attention for a few minutes.

From the delicacy of these root-hairs, and from their springing at right angles from the surface of this part of the root, radiating in all directions between the particles of soil, to which they immediately proceed to glue themselves, it is obvious that they are saved from being torn away as the tip of the root is slowly driven forwards between the particles of soil; if they were to arise on the tip itself, or on the parts which are elongating behind it, they would infallibly be removed by the abrasion of the particles of soil. Instead of this, however, they become developed on the parts behind in successive multitudes as those parts cease to elongate.

At the same time, the thousands of points of attachment established by the root-hairs afford the holdfast which becomes more and more necessary as the apex of the root is driven further and further forwards, and as the weight of the aërial parts of the plant, with their increasing surfaces exposed to wind and weather, become larger.

Meanwhile, leaving aside for the moment the consideration of how these millions of root-hairs take up the water and food-matters from the soil, the young root has been making preparations for obtaining a still firmer and wider holdfast on the soil, which will, at the same time, enable them to absorb water and food-materials at millions of new points further and further removed from the centre at which the primary root commenced its operations. To understand this, I must call your attention to this diagram, showing how the branching of the root proper is brought about. In the interior of the growing root a number of cells begin to multiply at certain points, and to form the young beginnings of lateral roots or rootlets; further back you see these young lateral roots upheaving the tissues of their parent root as minute knobs. By this time, however, these portions of the mother root have ceased to grow in length, and thus the tender little tips of the lateral roots can protrude and be pushed into the soil around without danger of being dragged off or injured, as they would inevitably be if this part of their mother root were still actively elongating. Notice carefully the exquisite adaptation to the circumstances, though brought about in a slightly different manner; no time is lost in the preparation of the young root branches within the tissues of the parent root, but the tender tips, as in the case of the root-hairs, only proceed to grow radially into the surrounding soil when the growth of the mother root in a direction across their long axes has ceased.

Time will not allow of our examining these matters more in detail; but I cannot avoid calling your attention to the fact that these lateral roots are sensitive to gravitation in a manner different from the primary root—they grow, not straight down towards the centre of the earth, but across the vertical, it may be more or less inclined, in different cases. In other respects they

resemble the primary root generally, in their turn producing root-hairs and daughter roots, which radiate from them in all directions into new portions of the soil, as shown in this diagram.

I need not do more than point out to you that it would be difficult to conceive of a series of adaptations better calculated to insure that the various parts of the root-system come successively in contact with the whole mass of soil traversed; and when your eyes follow mine over this diagram, you will agree that matters have become so arranged, so to speak, between the roots and the soil, that every part of the latter is laid under contribution. Notice how this vertical cylinder of earth is first bored through by the primary root, and then traversed in all directions by the root-hairs, in a wave, as it were, passing from above downwards. Next come the lateral roots, burrowing in all directions from the main shaft, and each in turn demanding toll from the cylinder around it by means of its wave of root-hairs. Then follow tunnelings along the lengths of each of these rootlets, and on all sides at right angles to them, until every nook and cranny has been investigated by these enterprising rootlets and their prying root-hairs. Quite apart from all else, therefore, the root-system obtains a greater and greater holdfast on the soil by driving its tips in on all sides.

But I must now draw your attention to some matters which throw even more light on our subject. The root-hairs, as they develop successively from above downwards on the primary root, or on the lateral rootlets, come into the closest contact with the particles of soil—contact so close and firm, in fact, that they cannot be torn away without injury. There are experiments to prove that their cellulose walls become actually moulded and gummed on to the solid particles of quartz, slate, and other rocks of which ordinary soils are composed, and this diagram shows how we can lift up a relatively large cylinder of soil adhering to the root-hairs of a young seedling.

Now you are probably aware that the sort of soil in which a healthy plant flourishes contains air-bubbles as well as water in the interstices between the particles, and into which the root-hairs become insinuated. Bearing this in mind, you will have no difficulty in understanding from the diagram how the root-hairs absorb the aërated water necessary for their well-being. I need simply make the additional remark that each little bag-like root-hair takes up the liquid water through its permeable walls into its interior, in some respects very much as a bladder full of a solution of sugar or salt would absorb water if placed in it.

But this water taken up by the root-hairs and passed on into the rootlets and so on up the stem (a process for which provisions are made which we cannot go into here), is not pure water; it contains, besides air, certain small proportions of the soluble matters found in all soils. It is, in fact, much like ordinary drinking-water from a well or spring, which always contains some matters in solution. But the roots want certain other minerals, which will not dissolve in pure water to a sufficient extent under ordinary circumstances. Well, the root-hairs, in making use of the oxygen which they, like all other living bodies, require, give off small quantities of acids which aid the solution of these more refractory matters.

And now I have finished—not because the subject is exhausted, but because the time at our disposal is. I hope the object has been attained, and that you fully realise how well worthy of study is a common living root. Not only is it instructive as a simple object of dissection, a subject upon which I have had no time to dwell, but the peculiar properties which stamp it as a living organ themselves afford material for much thought and investigation. When we go further, however, and see how the structure and the functions depend upon one another, some very curious reflections thrust themselves upon us; and if time had allowed us to look at these matters from the other platforms of view—to see how old errors have gradually been explained away on the part of observers, and how what may be called improved adaptations have arisen in the evolution of the root as an organ—these reflections would have obtained in depth. But we have taken a glimpse at matters still more comprehensive: we have touched upon that important question of the relation of the root to its physical environment, and it is not difficult to see numerous points where the struggle must have been intense before the plastic substance of the root was enabled to meet the requirements necessary before it could become a dweller in the land. The evidence of progress and adaptation to its environment on the part of the root is, in fact, so striking and conclusive, that we might take it as a text for a sermon on evolution were such necessary. I have been strongly tempted to occupy some more time with reference to the interesting phenomena shown by roots which cling to trees and walls, &c., or which rob other plants of food-materials; and had time allowed, I would have liked to say a few words about some other adaptations, such as those by means of which roots become pulled up taut in the soil. However, these and other matters cannot be even mentioned, and, indeed, each one deserves a lecture to itself.

FOCAL LINES

WHEN a pencil of light proceeding from a luminous point is incident upon a prism, the rays after refraction do not as a rule diverge from a point, but from two short lines at right angles to each other at some distance apart depending on the angle of incidence of the pencil. These lines are known as the focal lines of the pencil. If the edge of the prism be vertical and the axis of the pencil lie in a horizontal plane, the focal lines are respectively horizontal and vertical. The position of the horizontal line is independent of the angle of incidence of the pencil, its distance from the prism being the same as that of the luminous point, or with the notation of Parkinson's "Optics" (p. 88)—

$$v_2 = u.$$

The distance from the prism of the vertical focal line is, on the other hand, dependent on the angle of incidence, its position being given by the formula—

$$v_1 = \frac{\cos^2\phi' \cos^2\psi}{\cos^2\phi \cos^2\psi'} . u.$$

The image of an object viewed through the prism will appear between the two focal lines, and will be formed by the circles of least confusion. The two focal lines will coincide in position, and they, and the circles of least confusion, will consequently become points if $\phi = \phi'$, that is, if the prism be placed in the position of minimum deviation.

All these phenomena of refraction by a prism, which are of great importance to the spectroscope, may be verified in a very striking manner by using as an object a piece of wire gauze, placed so that one set of wires is horizontal and the other vertical, and illuminated by a sodium flame placed behind it. If the light pass directly from the gauze to the prism, the focal lines are of course virtual, but they may be easily viewed and their positions identified by means of a telescope which will focus an object at a short distance. For one position of the eye-piece of the telescope the vertical wires are seen distinctly while no horizontal wires are seen; whereas for another position the horizontal wires may be focused, but then the vertical ones are no longer visible unless the prism is in the position of minimum deviation. Between these two positions of the eye-piece is a third, for which a blurred image of the gauze is seen corresponding to the circles of least confusion. The positions of the lines may be determined by ascertaining where an object must be placed, when the prism is removed, so as to be in focus in the telescope for the two positions of the eye-piece corresponding to the two focal lines respectively.

The experiment is, however, much more striking if the focal lines be made real by interposing between the gauze and the prism a convex lens of somewhat long focal length. The vertical and horizontal images may then be viewed by means of an ordinary watchmaker's glass, or, better still, by a telescope eye-piece mounted behind a second gauze with its wires set at 45° to the horizon. With this arrangement the images corresponding to the two focal lines can be seen very clearly, and their distances from the prism accurately measured. It is very interesting to place the prism first in the position of minimum deviation, and focus the magnifier upon the image of the gauze, showing both horizontal and vertical wires clearly defined; then on gradually turning the prism the vertical lines disappear completely, leaving a set of horizontal bars across the uniform field, thus verifying the first formula cited above.

If however, the eye-piece be drawn back some way, a badly-defined image of the gauze can be obtained corresponding to the circles of least confusion, and, on withdrawing the eye-piece still further, the horizontal lines disappear entirely, while the vertical lines come out sharply defined as a set of vertical bars across a uniform field. As the experiment was arranged here, with a prism of about 9° and the horizontal focal line about two feet from the prism, the distance between the two images was fully six inches when the prism was turned through an angle of about 15° from the position of minimum deviation.

The properties of the focal lines formed by a pencil incident

obliquely upon a lens can be verified in an exactly similar manner. It follows from the formulæ given in Parkinson's "Optics" (p. 101) that, with the usual notation—

$$\frac{u - v_1}{u - v_2} \cdot \frac{v_2}{v_1} = \sec^2\phi.$$

The verification of this formula by the method of observation described above has been found to be a very useful and satisfactory class experiment. W. N. SHAW

Cavendish Laboratory, Cambridge

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The election of Mr. A. Marshall as Professor of Political Economy will be welcomed by all who knew the value of his work when formerly in residence as Lecturer at St. John's College.

The Senate has sanctioned the recommendation that 700*l.* be expended on the purchase of microscopes for the biological classes, on which sum interest at 4 per cent. is to be paid, a small terminal charge being made to the students for the use of the microscopes.

The Botanic Garden Syndicate have recommended the increase of the stipend of the Curator of the Botanic Garden from 150*l.* to 200*l.* The Syndicate have watched with interest the zeal and skill with which Mr. Lynch has applied himself to the conduct and development of the garden. The improvement during his curatorship has been very considerable, in fact remarkable; and the reputation of the garden among botanists and horticulturists, both at home and abroad, has risen so much that it is now considered to hold a place in England second only to the Royal Gardens at Kew. Sir Joseph Hooker has said that the Garden, under Mr. Lynch's able management, is rapidly rising to eminence as one of the very best in Europe. The Syndicate express their strong approval of the assistance which Mr. Lynch's intelligent appreciation of the requirements of botanical teaching has enabled him to render to the University.

DR. GILBERT, Professor of Rural Economy at the University of Oxford, and the associate of Sir J. B. Lawes in the Rothamsted experimental work, has accepted the post of Honorary Professor of Agricultural Chemistry at the Royal Agricultural College, Cirencester, rendered vacant by the death of Dr. Voelcker.

MR. D'ARCY WENTWORTH THOMPSON, B.A., was on Monday elected Professor of Biology, University College, Dundee.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, December 13.—Prof. Guthrie, President, in the chair.—The following communications were read:—On the effect of an electrical current on the rate of thinning of a liquid film, by Profs. A. W. Reinold, F.R.S., and A. W. Rücker, F.R.S., read by Prof. Reinold. In 1877 the authors communicated to the Royal Society an account of some experiments upon the electrical resistance of liquid films. The results then obtained showed that there was some disturbing influence present, and the authors now find this to be the action of the current upon the film itself. The films experimented on were, as in the original experiments, cylindrical and vertical, formed upon two coaxial platinum rings which are the electrodes by which an electric current can enter or leave the film. The mode of formation of these films and the precautions necessary to keep them from gaining or losing moisture by condensation or evaporation have been already described before the Royal Society (*Phil. Trans.*, 1881, part 2). When such a film, just formed, is left to itself, it shows a set of colours of different orders arranged in horizontal bands; as it thins under the action of gravity, these bands gradually broaden out, and descend; a black band soon appears at the top, which likewise extends downwards. If a current is now passed downwards through the film, the motion of the colour-bands is accelerated, showing that the effect of the current is to assist gravity in thinning the film; the black band, however, becomes in part or entirely white. This upon examination is found to be due to the following action; the film is not directly dependent upon the upper ring, but is attached to it by a comparatively thick mass of liquid. The action of the current is to transfer liquid in its own direction, thus, like gravity, thinning the film; the mass of liquid, however, on which the film hangs, by this same action is forced down into the black portion, which consequently becomes white. If the current be passed upwards, the reverse effects occur: the downward motion of the bands is retarded, or, with a strong current, reversed. The explanation is precisely the same as before: the liquid is transferred along the film in the direction of the positive current; it sometimes collects in the form of pendent drops attached to the upper ring; these increase in size, and stream down the sides of the film. Prof. Reinold then formed a plane film between two horizontal wires; the film was illuminated by the lime-light, and its image projected upon a screen; the motion of the bands of colour in the direction of the current produced by fifty Grove's cells was clearly shown.—In a discussion which followed upon the transference of matter with the current, Prof. Ayrton described some experiments recently made by Prof. Perry and himself, which showed that certain metals were carried through mercury in the direction of the current. Mr. Boys remarked upon the apparent inertia of the film; the current seemed to require time to develop its action, no motion of the colour-rings being visible for some seconds after making the current.—Dr. Stone exhibited a tuning-fork interruptor commutator. This is an instrument for reversing an electric current through a circuit a given number of times per second. From the free end of a spring, kept vibrating in unison with an electrically maintained fork, by an electro-magnet in the circuit of the fork acting upon an iron armature attached to the spring, project two small aluminium plates, side by side, but insulated by ebonite from the spring and from each other. These are connected by fine wires, which do not interfere with the vibration of the spring, to screws upon the base of the instrument, to which the poles of a battery are joined. The motion of each plate is arrested upwards and downwards by aluminium-stops, so that there are four such stops arranged at the corners of a rectangle. They are connected in pairs diagonally, and each pair is in communication with one end of the external circuit. Thus, when the spring is up, the current flows to the aluminium plates, and is transmitted through the circuit in one direction; when the spring is down, it flows by the lower stops in the opposite direction. The electromotive force is thus reversed in the circuit twice as many times as the fork vibrates per second.—Mr. Lewis Wright exhibited his new oxy hydrogen lantern microscope. Details of this instrument will shortly be published. Geological, medical, and biological specimens were exhibited upon the screen with great distinctness, the definition being singularly perfect under the highest powers.

Anthropological Institute, December 9.—Prof. Flower, F.R.S., President, in the chair.—The election of Miss Müller was announced.—Sir John Lubbock read a paper on marriage customs and relationships among the Australian aborigines. Many tribes are divided into families or gentes, and no man may marry a woman of his own gens. For instance, among the Mount Gambier (South Australia) natives every man is a Kumite or a Kroki, every woman a Kumitegor or a Krokigor. No Kumite may marry a Kumitegor, nor a Kroki a Krokigor. In many cases the divisions are more complex, but the general principle is that no man may marry a woman of the same gens as himself. These divisions often extend through many tribes and over hundreds of miles. But while these restrictions are imposed on marriage, on the other hand, in one sense, every man is considered as a husband of every woman belonging to the gens with which he is permitted to marry; so that, as Messrs. Fison and Howitt forcibly put it, he may have 1000 miles of wives. But though we may call this marriage, and it is a right which in old times was generally, and to a certain extent still is, recognised as perfectly legal and respectable, it does not help us to the origin of marriage in our sense. "Communal marriage" (as he had proposed to call it) was no doubt aboriginal, and founded on natural instincts. But how did the institution of "individual marriage" arise? "Individual marriage" cannot be derived from "communal marriage," because, however much the gentes may be subdivided, the wives must remain in common within the gens. Messrs. Fison and Howitt did not, he thought, sufficiently realise the fundamental distinction between these two customs. They spoke of both as "marriage," and indeed we had no other word for them. Yet they were radically distinct, and even opposite in their characteristics. Sir John Lubbock had suggested, in his work on the "Origin of Civilisation," that, while in such a state of things no man could

appropriate a woman belonging to his own tribe exclusively to himself, still that, if he captured one belonging to another tribe, he thereby acquired an individual and peculiar right to her, and she became his exclusively, no one else having any claim to, or property in, her. He considered that this explained the prevalence of the form of capture in marriage, first pointed out by the late Mr. McLennan in his excellent work on "Primitive Marriage," but which Mr. McLennan attributed to the prevalence of exogamy, or the custom of marrying outside the tribe; while, on the contrary, Sir John Lubbock maintained that individual marriage was founded on capture, because this could alone give a man an exclusive right. This view has recently been contested by Messrs. Fison and Howitt, but Sir John replied in detail to their arguments, and supported his suggestion by strong evidence, some even taken from their own work.—The Director (Mr. Rudler) read a paper on the Jeraeil or initiation ceremonies of the Kurnai tribe, by A. W. Howitt, F.G.S., in which the author gave a detailed account of a Jeraeil at which he himself was present, and drew attention to the manner in which it differs from, or has resemblance to, the Kuringal of the Murring.

EDINBURGH

Royal Society, December 1.—Thos. Stevenson, C.E., President, in the chair.—Mr. Stevenson made some remarks in connection with his election as President.—Sir W. Thomson communicated a paper on the distribution of energy between colliding groups of molecules, in which he drew attention to Boltzmann's extension of a theorem given by Clerk Maxwell for the first time twenty-four years ago. He pointed out that, while Maxwell made his simple theorem the basis of his kinetic theory of gases, Boltzmann's extension would, if true, be fatal to that theory. Prof. Thomson also stated that the proofs of Boltzmann's theorem are not satisfactory. The theorem itself seems improbable, and cannot be accepted unless rigidly demonstrated. He wished to draw the attention of mathematicians to the subject, so that the truth of the theorem might be tested. Prof. Crum Brown remarked that, even in the simplest cases to which the theorem might be applied, there seemed no accordance between its results and actual fact. Prof. Tait stated that the truth of the theorem had seemed to him to be so doubtful that he had called the attention of the Society to it two sessions ago, and had also referred to the matter in his recently-published book on "Heat."—Sir W. Thomson then communicated a paper on the dynamics of reflection and refraction in the wave-theory of light. He gave a complete mathematical theory of reflection and refraction of light supposed to consist of vibrations in homogeneous elastic media of different densities and rigidities in the two substances through which the sight was considered to pass. The theory confirmed the views of Stokes, Lorenz, and Rayleigh, that the density of the luminiferous ether is different in different transparent substances, while its effective rigidity is equal.—Sir W. Thomson then gave a paper on Kerr's discovery regarding the reflection of light from a magnetic pole. Kerr's discovery forms an extension of Faraday's observations on the action of magnetism on polarised light passing through transparent substances. The plane of polarisation of light reflected from a polarised magnetic pole is rotated through a definite angle in a direction opposite to the conventional direction of the Amperian current. Some time passed before Kerr's results were obtained by any other observer. Kundt finally succeeded in verifying them, and added the new discovery of the rotation of the plane of polarisation of light passing through a transparent film of iron. In his paper Sir W. Thomson gave a dynamical explanation of these phenomena.—Prof. Tait exhibited a new form of apparatus for determining the compressibility of water. Formerly he measured the compression produced by a given pressure. In his new method he measures the pressure required to produce a given compression. His arrangement allows him to make any number of measurements in rapid succession at any one temperature. Then the temperature can be raised, and corresponding measurements made without once opening the compression-apparatus. Thus experiments which formerly would have taken weeks for their completion could now be accomplished in a single afternoon. Rude results only have been obtained as yet with the old very massive compression-apparatus. These seem to show that the diminution of compressibility at higher pressures becomes less at higher temperatures, and may possibly even become an increase for the first few hundred atmospheres pressure. But no very definite statements can be made till the new, light but strong, apparatus now being made is available for experiment.

PARIS

Academy of Sciences, December 15.—M. Rolland, President, in the chair.—On the forms of the surface of the luminous wave in an isotropic environment situated in a uniform magnetic field: probable existence of a peculiar double refraction in a direction normal to the lines of force, by M. A. Cornu.—On the algebraic relations between the hyper-elliptic functions of the *n*-order, by M. Brioschi.—On the determination of a special case of isomerism in the acetones, by M. G. Chancel.—On a method of inoculating the large ruminants with the virus of tuberculosis, by M. G. Colin. The experiments made on these animals afford a means of exactly measuring the period of incubation of the tuberculous elements, and determining the time required for the tubercules to pass to the state of transparent granulation.—On the variations of the ozone present in the atmosphere during the late outbreak of cholera in Paris and Marseilles, and on the advantages obtained from ozoneine, by M. Onimus. In both places there was a perceptible diminution of the atmospheric ozone during the prevalence of the epidemic, while a marked difference was observed between the ozonometric condition of the air this year compared with the preceding. In Marseilles the mean for July of this year, when the epidemic was at its height, was 0·86; that for the corresponding period in 1883 as high as 2·17. In Paris the mean for November was 0·44 and 1·82 respectively. The author infers, not that the absence of ozone is the cause of the disorder, but that it is a favourable condition for its development, while it is certain that the presence and persistence of ozone helps materially to arrest its progress. His experiments with Beck's preparation of ozoneine on men and animals were attended with excellent results, and produced no ill effects, even when administered in large doses. Its action affects chiefly the central nervous system, on which it produces a sedative effect, tending to show that this region is the main seat of the malady.—On the theory of the figure of the planets, by M. O. Callandreau.—On a trigonometric formula of interpolation applicable to any values of the independent variable quantity, by M. G. Fouret.—On the sections of mathematical functions, by M. Laguerre.—On the conditions necessary to determine the photometric value of intense foci of light, whether electric or solar, by M. Berthelet.—On some processes of practical spectroscopics, by M. Eug. Demarçay.—On the mutual attraction of bodies in solution and of solid bodies immersed, by M. J. Thoulet. The author shows that, when a salt is dissolved and a solid body immersed in the solution, an attraction is set up between the two substances altogether independent of any chemical action, and that this attraction is in direct proportion to the surface of the solid body.—Note on the dissociation of the hydrate of chlorine, by M. H. Le Chatelier.—Contributions to the study of brucine, by M. Oechsner de Coninck. It is shown that, like cinchonine, brucine contains in its molecule a tetrahydruret of quinoleine. Thus is again confirmed Wischnegradsky's hypothesis that the pyridic and quinolic bases exist in the state of hydrurets in the fixed alkaloids.—On the formation of the shell of the egg of *Scyllium canicula* and *Scyllium catulus*, by M. E. Perravex.—On the biological development of the Chelifer group of Arachnida, by M. Ch. Robin.—On the structure of the digestive apparatus of *Cantharis vesicatoria*, *Epicauta verticalis*, *Lytta fabricii*, *L. atrata*, and some other members of the Cantharides group of insects, by M. Alph. Milne-Edwards.—On the anatomical structure of the peduncles, compared with that of the ordinary axes and of the petioles in plants, by M. E. Laborie.—Account of two specimens of abnormal growth in the mushroom family, by M. Ed. Heckel.—Generic characteristics of Pleuraspidotherium, a mammifer of the Lower Eocene formations from the neighbourhood of Rheims, by M. V. Lemoine.—On the fossils of the Carboniferous strata found in a well recently sunk at Lubière in the Brassac Basin, by M. Grand'Eury.—Note on the periodical recurrence of the crepuscular glows, by M. J. J. Landerer. The recent reappearance of this phenomenon precisely at the same period as last year is regarded by the author as an argument in favour rather of a cosmic than of a volcanic origin.—M. Mascart was elected a member of the Section of Physics, to replace M. Jamin, recently appointed Perpetual Secretary.

BERLIN

Physiological Society, November 14.—Dr. König spoke on colour-blindness. A ray of light decomposed by calc-

spar into two polarised beams perpendicular to each other showed, after passing through a quartz plate, when viewed through a Nicol prism, two halves of different colours in the field of vision of the ocular lens, the colours of these halves varying with the position of the Nicol prism. In the case, however, of a so-called colour-blind or bichromatic eye there was a position of the Nicol prism in which the two different colours in the halves of the field of vision appeared alike. The position in which the colours appeared alike was not always the same, but varied with the thickness of the quartz plate, with the intensity of the light examined, and with the individuality of the bichromatic eye. An instrument of this description was therefore an apparatus that might be depended on for the detection of colour-blindness. Normal eyes, in whatever position the Nicol prism might be held, saw different colours; colour-blind eyes, when the Nicol prism was held in a certain position, saw similar colours. The person whose eyes were to be tested was made to look through the apparatus towards one or other source of light, and if at last, after a greater or less number of turns of the Nicol prism, he saw but one colour, then that person was proved to be colour-blind. The examination of a large number of persons—about fifty—who confounded red and green colours, usually distinguished as red- or green-blind, resulted in showing that, with an equal intensity of light, and with the same apparatus, a part of the colour-blind, on the Nicol prism being placed in a certain position, saw similar colours, while the remainder observed a corresponding similarity of colours with another position of the Nicol prism, this second position producing the same result for all persons of that category. The colour blind being by this means separated into two sharply-defined groups, neither shading into each other nor into the group of normal eyes, it was a matter of much interest to investigate whether these two groups of colour-blind eyes showed any other characteristic peculiarities. Among the methods adopted for determining the colour-blind, that of examining their spectrum, which was said to appear always shortened in different ways in the different cases of the red- and green-blind, was largely applied. It was seen, however, that there were so many particulars to be taken into account as affecting the extent of the spectrum, even in the case of sound eyes, that that method was by no means available for the precise and distinctive measurements here required. Another method, that of determining the neutral point, seemed well adapted for exact physical utilisation. As was known, Young's theory of the perception of colours assumed that in the retina there were three different nerve-elements perceptive of colour: one perceiving red, another green, and the third violet. If the perceptive capacities of each of the nerve-elements were traced as ordinates on the spectrum as abscissæ, three curves would appear, of which the first would have its maximum in red, the second in green, and the third in violet. If all three nerve-elements were acted on with equal force by a stimulus of light, then the sensation of white was produced; but if they were affected in different degrees, then the sensation of partial colour was the result. In the case of the colour-blind there was, according to this theory, one curve wanting, the red, or green, or violet. The two remaining ones, in that case, must now cut each other in one point, and at the spot where this point hit the spectrum, the colour-blind person, his colour-perceptive elements thereby being affected with equal force, must see white: at that spot was the neutral point. The finding of this neutral point by means of a movable slit through which a spectrum could be viewed was, however, attended with several inconveniences prejudicial to precision. Dr. König had therefore constructed a special apparatus for ascertaining the neutral point. [This was described at length by the speaker in his communications to the Physical Society, NATURE, vol. xxix. pp. 168, 496.] In nine persons, some of whom were red, and others green-blind, the neutral points were determined, and the following observations made: (1) The neutral point was able to be measured with great precision in each case of colour-blindness, the average error being at the greatest, 0·4 millionth of a millimetre, wave-length, and in the least 0·1 millionth of a millimetre. (2) The neutral point in the case of all colour-blind persons, green- as well as red-blind, was situated at one spot of the spectrum, in the green-blue, between the wave-lengths 492 and 505 millionths of a millimetre. A division of the colour-blind into two groups, such as could be so exactly carried out with the leucoscope, was, however, not possible through determinations of the neutral point, for on the leucoscope colour-blind persons of different descriptions had their neutral points quite close to each other, while eyes leucoscopically alike had their neutral points most remote from each other. (3) With increasing intensity of light the neutral point was displaced in all cases of colour-blindness towards the more refrangible end of the spectrum. Among the results of the measurements referred to, that cited under (2) was of extreme interest for the theory of colour-blindness. One conclusion it yielded was that the idea of the nature of colour-blindness derived from Young's theory received no support from the experimental examination of the consequences deduced from it. Dr. König had occasion quite recently to examine a so-called violet-blind person, and another who was totally colour-blind, but he had not yet had time to reduce the measurements he had carried out respecting these two cases, and would therefore reserve further particulars of them to another opportunity. The fact established in (1), that with the apparatus constructed for ascertaining the neutral point separate small sections of the spectrum may be so sharply marked off and determined according to their undulatory length, induced Dr. König to make use of this apparatus for investigations respecting the colour-perceiving capacities of normal eyes. In co-operation with Dr. Dietrici he had first examined the degree of sensitiveness to distinctions of colour in the different parts of the spectrum between 650 and 430 millionths of a millimetre, undulatory length, and gave a summary of the results thereby obtained which he had already communicated to the Physical Society (NATURE, xxix. 496, xxx. 308). It deserved here, however, to be brought prominently forward that the maximum of colour-sensibility of the two normal eyes coincided with that spot of the spectrum at which the neutral point occurred in the colour-blind, and that this maximum of colour-sensibility shifted, in the same way as the neutral point, with increase of the intensity of light towards the blue end. The further investigations contemplated by Dr. König relate to the colour-sensibility beyond the wave-lengths 650 and 430 millionths of a millimetre, and determinations in regard to colour-contrast.

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